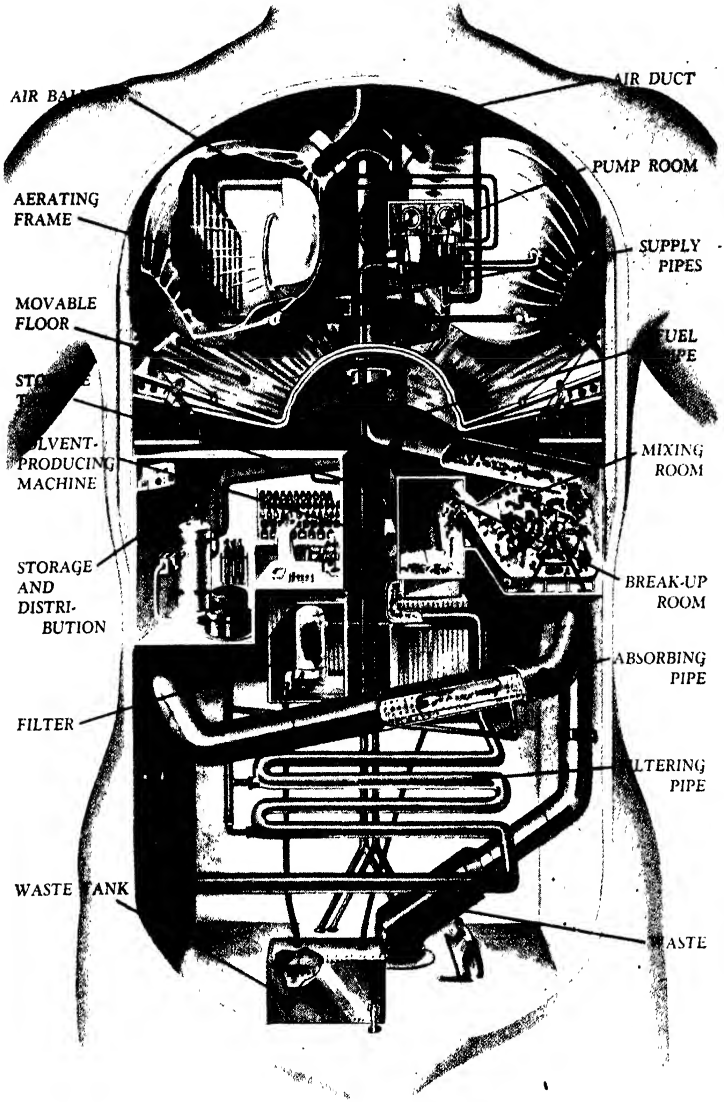

THE FACTORY OF THE HUMAN BODY

Compare this with the illustration on page 26

THE WONDERFUL STORY OF YOU

How Your Body Works
How Your Mind Works

THE NATURE OF YOUR PHYSICAL, MENTAL AND SPIRITUAL MAKE-UP AND THE PART EACH PLAYS IN HUMAN LIFE FROM BIRTH TO OLD AGE

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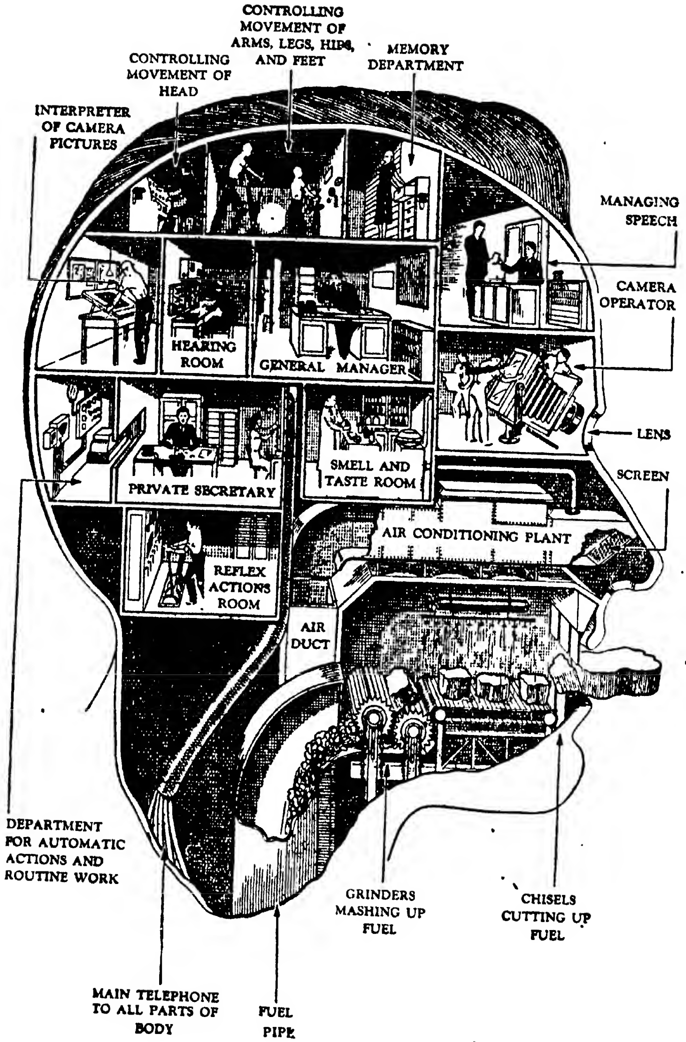
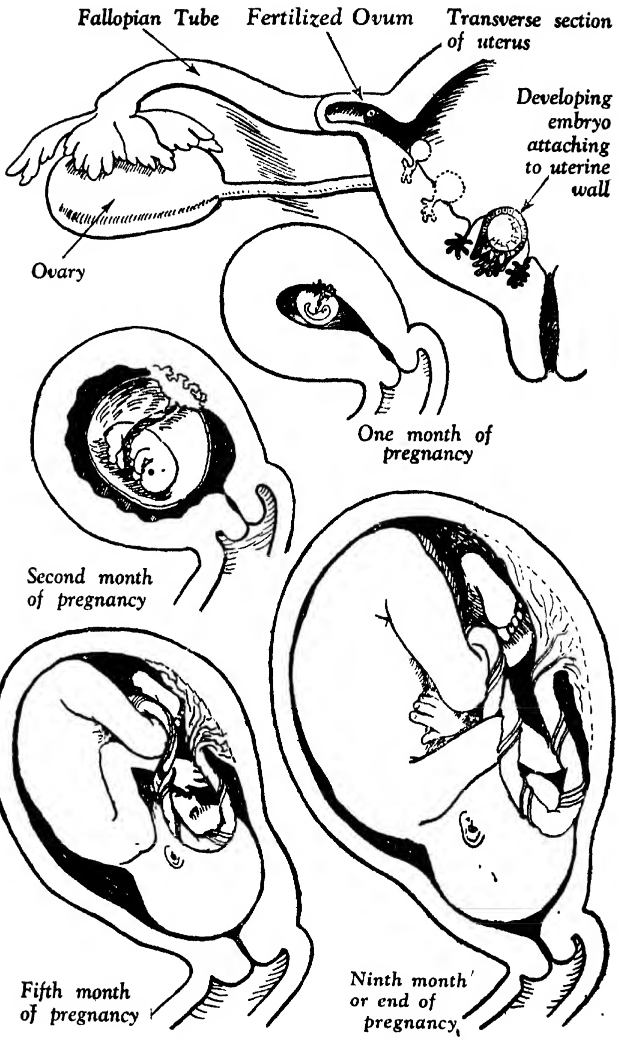


CONTROL CENTRE OF THE BODY

Here are the various centres of the brain shown as technical departments, with a central switchboard which has lines running to all parts of the body.

CONTENTS



STAGES OF DEVELOPING EMBRYO

These diagrams show how the tiny ovum, barely visible to the naked eye, develops in nine months into the human baby as we see it at birth.

PART 1 HOW YOUR BODY WORKS

CHAPTER ONE

HOW YOU COME INTO THE WORLD

Nature of living material. Elements of the human body. How a cell reproduces itself. Structure of the human ovum. Multiplication of ovum cell after fertilization. Stages in growth of embryo. Formation of skeleton. Heart and circulation. Development of vital organs. Process of birth.

ALL living things, animal or vegetable, are composed of one material. Put in terms of clothing, it is as if there were no cloths available save only cotton; from this must be made the underwear, the coats, the hats, the boots —everything that is to be worn.

This remarkable cloth that Nature has manufactured for herself is called protoplasm. Tiny bits of it constitute bacteria or the individual cells of any plant or animal.

Even when myriads and myriads of these little pieces arrange to live together in a great community like the human body, they are still pieces of protoplasm.

All the universe that we know can be reduced to a number of elements. These elements have never been broken down into anything simpler; they seem to be the basic forms of matter. Scientists know ninety-five of them, but less than a score are at all common; the rest are found in rare earths or rarer gases.

Twelve of them are found regularly in the body of man, and of this dozen only six are present in any quantity. These six are carbon, hydrogen, oxygen, nitrogen, phosphorus and calcium.

The other elements which are found in the human body appear in relatively very small quantities: they are chlorine, sulphur, sodium, potassium, magnesium and iron. If some energetic chemist reduced the body of a man to its elements he would have approximately:

	lb.		oz.
Oxygen	106	Magnesium	12
Carbon	21½	Chlorine	4
Hydrogen	13½	Sodium	3½
Nitrogen	4½	Sulphur	2½
Calcium	2	Potassium	1
Phosphorus	1½	Iron	$\frac{1}{10}$

There are also traces of fluorine, iodine, silicon and other elements.

Nearly two-thirds of that body would be hydrogen and oxygen combined to form water.

From compounds of these elements the living protoplasm is formed. Some of the most complicated carbon compounds are those known as proteins, which are made up of carbon, oxygen, hydrogen, and nitrogen, and sometimes have some sulphur and/or phosphorus in them as well. Egg-white (or albumen) and gelatin are examples of proteins.

Protoplasm is a sort of town made up of a number of these proteins mixed together. It is different, however, from any other mixture of proteins that the chemist might make in his laboratory, because it is endowed with that mysterious property called life. So far, no chemist has succeeded in making protoplasm out of any combination of its elements.

Characteristics of Life

This thing called life shows itself by four special signs: irritability, spontaneous movement, metabolism and reproduction.

Irritability means that it responds to its environment. However tempting the morsel that is presented to a piece of wood, the wood will never move towards it; however menacing the hammer poised over a block of stone, the stone will never shrink away. But when a particle of foodstuff is put near a living thing, however simple, the protoplasmic structure will, sooner or later, tend to move towards it; or when something unpleasant or dangerous is put near, protoplasm will shrink away.

Spontaneous movement means what it says. Living things tend to change their position, but however long you leave a non-living thing on your desk it will never move across to look at the other side —unless the duster gives it a push.

Building Up and Breaking Down

Metabolism means that protoplasm is constantly undergoing internal change, however quiet it may be from outside. It is always taking in new material, building it up into protoplasm, and casting out the waste. This may also mean that it grows in size, if the building up is greater than the breaking down. Some non-living things grow, as is well known to the schoolboy or schoolgirl who has prepared crystals from solution. But crystals grow by adding on layer after layer to the outside; living things grow by this building up and breaking down in their intrinsic substance.

Finally, however long you leave your stick or stone it will never multiply, but if you leave a protoplasmic structure alone you are very likely to come back and find it has become two, or perhaps two thousand.

Nature experimented widely with simple blobs of protoplasm and an enormous amount of this kind of life exists—all the many kinds of bacteria, which represent a very successful way of living, though very different from our own—but

for some reason another ground-plan was tried: that of enclosing a blob of protoplasm in a thin skin and setting up a central government in the middle of it to control the whole. This unit is called a cell: the skin is the cell membrane and the central government is a blob of protoplasm of slightly different composition called the nucleus.

This ground-plan has been used ever since for every kind of life. Everything living—except the bacterial microscopic blobs—is made up of cells. Some cells live an independent life. There is, for example, to be found in stagnant water a single cell called the amoeba. It can be seen only under a microscope, but it is a good example of what is called a unicellular organism. It shows all the properties of living protoplasm and moves sluggishly about by altering its shape so that one half of it flows in the desired direction and the other half flows after it.

Cell Communities

Before long, the idea occurred to a number of cells to live together, just as it might occur to a lone savage that it would be a good plan to form a community. A very simple kind of multicellular organism is a tube which has two layers of cells: an outside layer and an inside layer. The outside layer is a rather different kind of cell adapted specially to protect, while the inside layer is adapted to digest.

This process of setting aside certain cells to do certain jobs for the benefit of the whole is called division of labour, and the cells then become dependent upon each other, just as the members of a community are. The baker who bakes for all is dependent on the farmer who grows for all, and both in turn on the tailor who sews for all, and so on. In this way the protective cells lose all power of feeding themselves and have to depend on prepared food passed to them through the cell membranes from the nearest digestive cells.

Blood and Nervous Systems

Then this idea is carried further, and a third layer of cells appears between the other two. This makes complications, because the outer cells cannot get their food by direct passage from cell to cell as they could when every outer cell was in touch with an inner cell, so there has to be a carrier system to convey the products of one member of the community to the other members who need them. This carrier system, when it is fully developed, is called the circulatory or blood system.

Later on it is found useful to have also a telephone system, whereby messages can be conveyed more quickly than the goods travel by the slow carrier circulation. This telephone system is the nervous system.

When a unicellular organism wants to reproduce itself it simply splits in two. Complicated multicellular organisms sometimes reproduce by budding like a tree, but as they become more and more

complex, this becomes impossible. Then special cells are set aside for reproducing the new generation, just as other cells are set aside for digestion and breathing and manufacturing substances.

In some simple organisms, these cells are shed and grow into a new individual, but before very long this seems to prove unsatisfactory and a sexual system is produced. This means that one cell from two different kinds of individual—a male and a female—is needed to make a third individual of the new generation. Therefore every individual begins from one cell, but that one cell is formed by the fusion of two cells: one from the special reproductive organ of the father and one from the special reproductive organ of the mother.

The Human Ovum

In mammals these two cells meet in the mother's body and fuse, forming the new-generation cell, which is called a fertilized ovum. The human ovum is just visible to the exceptionally powerful eye, but easily seen and examined under the microscope. It is nearly spherical, measures about one hundred-and-seventy-fifth of an inch in diameter, and weighs about one fifteen-thousandth of an ounce. This little cell is surrounded by a thin membrane enclosing small spheres of fatty substances.

With the nucleus of the mother cell the nucleus of the spermatozoon, or father cell, establishes union, thereby rendering the ovum capable of further development; until, at the end of nine months, it will have increased in weight some fifteen hundred million times, and developed from a simple microscopic sphere into the human baby. The baby soon develops further into the adult—woman or man—with complicated tissues, and what has been described as "vast intellect, ambition, emotions of love and hate and varying moods."

Influence of Parental Cells

The exact lines of this physical and mental elaboration, though capable of being modified considerably by both emotional and material environment, are at least as much affected by the qualities of the two parental generative cells, regarded both separately and in combination. It is idle to talk about the effects of heredity and environment as though they were quite unrelated influences, to be considered apart from one another.

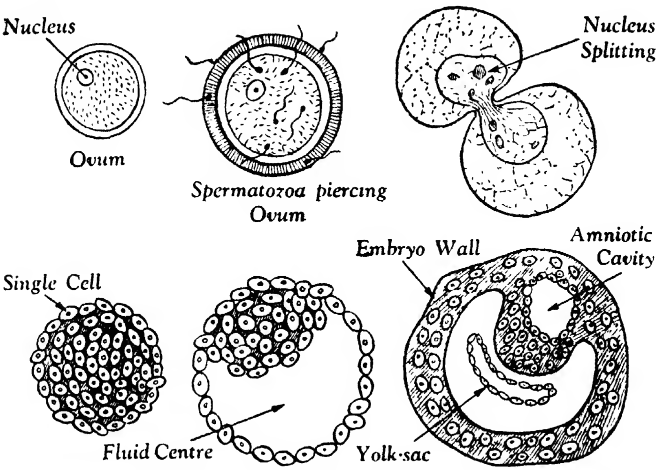
Indeed, the whole mysterious process of fertilization and development remains the most magical and, to the human mind, least comprehensible of all the phenomena we are capable of sensing. It is reasonable and understandable that all but the least curious of men and women should be anxious to know what has been discovered about the steps by which their complicated selves were built up from so tiny and so seemingly uncomplicated a beginning.

In us and other mammals, egg-cells are far fewer than the fertilizing male cells or spermatozoa. In

the human, the number of egg-cells possessed by the female individual during her whole life is established at a very early age. Each female child, it is said, has in her ovaries at birth some 36,000 egg-cells, no addition being made to this number after birth. These egg-cells are discharged from the ovaries, one at a time, each month from the age of about twelve or fourteen till about forty-five or fifty.

The sperm cells are very much smaller than the ova and they are so numerous that it is estimated that for every spermatozoon that comes into contact with an ovum ripe for union on its escape from the ovary, countless millions perish unused.

The human ovum, seen as a single cell, multiplies in geometric process of division superficially resembling the simple division into two equal parts of the amoeba. Even in the unisexual creature such as the amoeba, however, the process of division is not quite so simple as it at first appears to be. It is true that each half into which the amoeba divides is furnished with half of the nucleus and of a second specialized blob called the nucleolus.

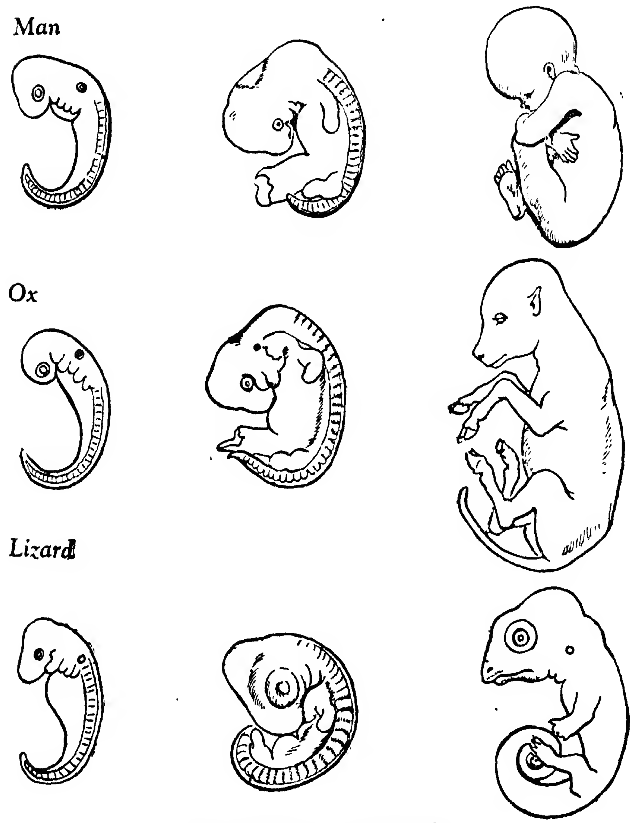


FIRST STAGES IN DEVELOPMENT OF OVUM

The ovum, after fertilization, divides into two cells (top right). These divide again and again and in a few days the ovum becomes a small ball of cells (bottom left). The inner cells (future embryo) then cluster in one patch, leaving a fluid space. Later a second fluid space appears (amniotic cavity) and a layer of cells separates to form the yolk sac, which is to nourish the embryo until it is able to obtain its food supply direct from the mother.

Before the organic cell actually divides, the nucleolus arranges itself into rods which split lengthwise into two. These rods are called chromosomes, and are thought to embody and transmit the characteristics of the particular organism.

The human ovum is dependent for its continued life and development on the junction with it of the



COMPARISON OF EMBRYOS

The remarkable similarity between animals and man in the early stages of development is clearly seen in these embryos of man, ox and lizard. The embryos on the left are shown shortly after formation (in man about a month old) and those in the centre are at a corresponding intermediate stage between formation and the full-term embryos seen on the right.

male cell, the spermatozoon. With the exception of the reproductive cells, the ovum and the spermatozoon, every cell in the human body contains twenty-four pairs of chromosomes. The ovum and spermatozoon, however, each has twelve pairs of chromosomes. The fertilized ovum, like the other cells in the body, contains the usual twenty-four pairs characteristic of the species, one half of this number being derived from each parent.

Evolution and the Embryo

During the nine months that elapse before its appearance in the world, the fertilized ovum passes through stage after stage; each stage curiously like one reached by some other animal whose development stops at that point.

Thus, at one stage, the human embryo has gill arches with clefts between them. From this fact it has been inferred that our early ancestors were water animals, obtaining their oxygen from the water by means of these organs, fully developed, after the manner of fish.

Later the fertilized ovum assumes other forms, resembling creatures higher in the scale of elaboration, from a study of which, scientists, such as Charles Darwin, T. H. Huxley and Haeckel, have inferred the probable evolutionary history of man.

This long slow process of change and building up, which has taken millions of years to arrive at its present stage, is echoed by the human embryo as it passes through its nine months of growth. The organs become less and less like those of more primitive creatures, the gills are replaced by lungs, and the foetus, or growing embryo, develops liver, kidneys, intestines and all the other structures which exist in the baby at birth.

Gill Arches and Clefts

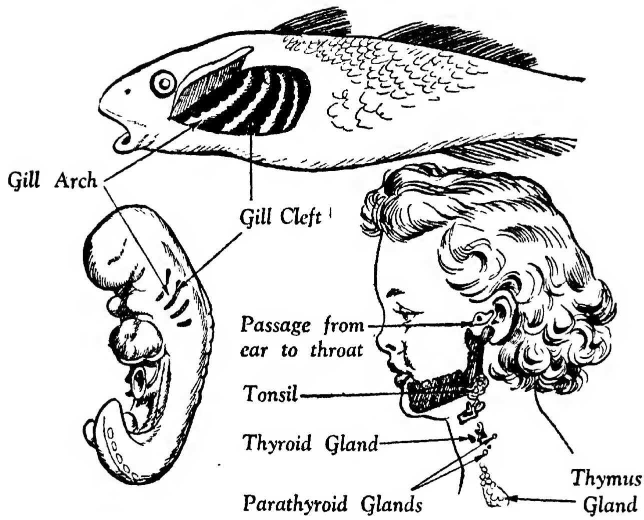
The question arises what then becomes of the obsolete organs. Curious and varied are their changes and uses in mature life. Let us take the several gill arches and clefts as an example.

From the first arch arise the muscles employed in mastication, and also one of the bones of the middle ear.

From the cleft between the first and second arches arise both the ear-opening and the Eustachian tube leading from the ear to the back of the throat. Here we have a connexion between the throat and the outside, reminding us of the passage that we find in adult fishes who obtain their oxygen from the water flowing through their gills.

From the second gill arch arise certain muscles of the face and another of the small bones of the middle ear; from the cleft between the second and third arches arises the palatine tonsil.

The third gill arch becomes the external carotid artery; from the cleft or furrow between the third and fourth arches, portions of certain glands situated in the throat, known as the thyroid and parathyroid, are derived.



FISH-LIKE ORGANS OF HUMAN EMBRYO

The month-old human embryo (lower left) has gill arches and gill clefts like those of a fish (above). These structures change during the period before birth and the corresponding organs are shown in the child on the right.

The fourth arch becomes the arch of the aorta on the left side and disappears on the right side; whilst from the last furrow arises a part of the thymus gland.

These transformations are sometimes very elaborate. The final links between the external receptive sense organs, the transmitting wires or nerves, and the subtle translator which constitutes the internal receptor are not established until the very last hours of foetal life.

When the fertilized ovum reaches the womb, it burrows its way actively, like a little parasite, into the soft, spongy lining and ends up in a little lake of blood from which it can derive some nourishment by passage through its outer cell membranes. It divides again and again, so that in a few days the number of cells of which it consists has become uncountable, and it looks like a fluffy white currant.

Unlike the fertilized ovum of the bird, it carries with it only a very little nourishment, but there is enough in the fat particles of the ovum to keep the cells going until they can open up the mother's blood spaces.

The next thing is that the currant begins to show differentiation

between the cells on the outside and the cells on the inside, and between the cells on a small patch on one side of it and all the rest. The cells in the patch are going to form the baby; the others are going to nourish them and help them to do it.

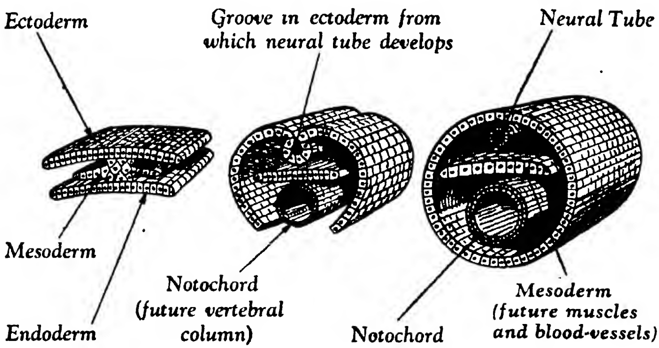
Then a little fluid begins to collect between the cells on the inside, which all collect at one end near the patch, and the cells on the outside. Thus, the currant is changed into a hollow ball with a lump at one end and a cavity filled with fluid.

The next stage is that the ball doubles into itself, just as if a firm thumb were pressed into a soft rubber ball, with the result that the embryo now has the shape of a U. It is then very like the simple multicellular organism we described as a tube, with inner and outer cells.

Very soon, as in the lowly creature, a third layer of cells appears between the first two. These three layers are the three primitive cell layers and are called ectoderm (the outside one), mesoderm (the middle one), and endoderm (the inner one).

Ultimately, the ectoderm is going to form protecting structures: the skin and all that is made from it; and the central nervous system. The mesoderm is going to form all the supporting tissues of the body, like the bones, the muscles and the blood-vessels. The endoderm will make the lining of the alimentary canal and the breathing system.

If we look through a microscope at a developing embryo, say, for example, a rabbit ovum which has been seven days in the womb, or a chick when the egg has been



THE THREE CELL LAYERS OF THE EMBRYO

The ectoderm develops into the central nervous system and protecting structures of the body. The mesoderm becomes bone, muscle and blood-vessels, while from the endoderm the vertebral column (beginning as the notochord), part of the digestive tract, and the breathing system are formed.

incubated for a few days, the patch which is going to form the embryo is seen as a broad, dark streak with a line running down the centre of it.

If this part is cut across, and the cut surface looked at through the microscope, the three layers of cells can be seen one above the other, the ectoderm appearing as a band of tall palisade-like cells, which are rather taller and more striking in the area which looked like a central line when viewed from above.

If, then, the further progress of this central line is watched, it is seen to dimple in the centre, again as if a thumb were pushing it down from above. Thus, it comes to form a deep groove, and presently the sides of the groove come together and meet above it, so that the groove is converted into a closed canal (see illustration on page 13).

Tube of Nervous System

Then, later still, though still early in the development of the embryo, the canal loses all contact with the original ectoderm surface layer and sinks down in the now much-thickened mesoderm layer to become a long enclosed tube running from head to tail. This is the tube of the central nervous system (neural tube), which is just a piece of very specially selected skin doubled in to develop its peculiar and wonderful activities (see opposite page).

While these changes have been going on in the ectoderm, the endoderm has been showing a rather similar change, a tube being folded in from the central cells of the endoderm streak. This tube also sinks into the mesoderm, so that it lies just below the nerve tube. (The terms "above" and "below" here imply that the embryo is lying on what will become its front, with its back uppermost.)

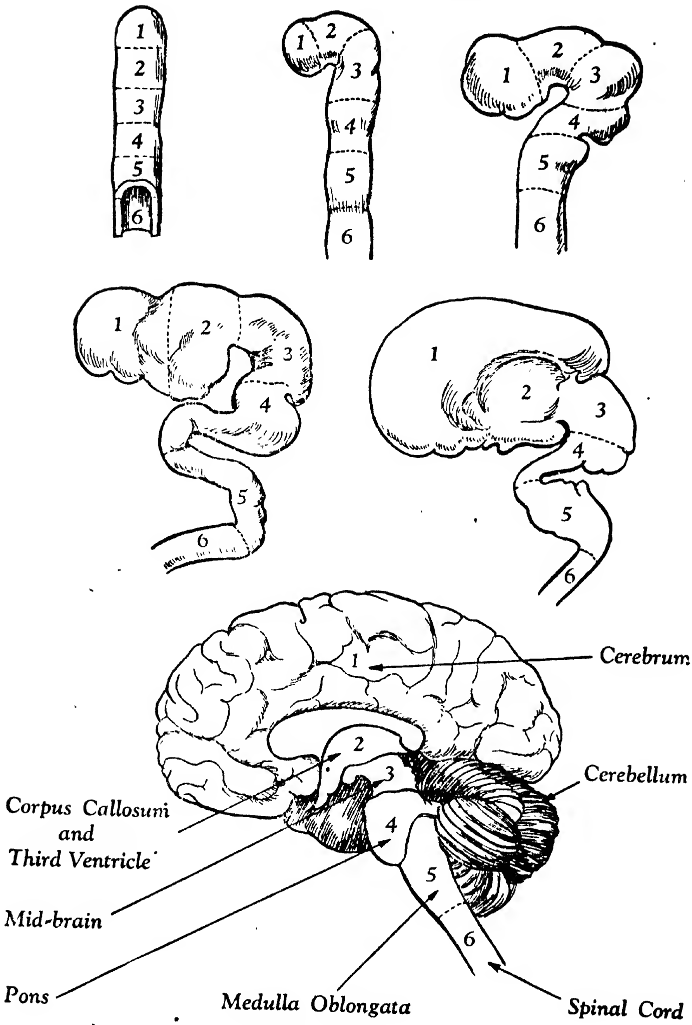
This second tube is called the notochord and it forms the nucleus of the future vertebral column. It is temporary only in man, being replaced by the bony spinal column, but it persists in some of the simpler fishes as the only supporting structure running through their bodies.

Muscles and Blood-vessels

The mesoderm meantime goes on getting thicker and develops into segments, reminding one of the arrangement in an earthworm. These segments are called somites, and there are some forty to fifty of them along the length of the body. Their segment arrangement is later lost in most places but is shown in the chest, where segments appear as the ribs and muscles between them. These mesodermal segments turn into the great muscle masses of the body, as well as into the blood-vessels and certain other structures.

While all this is going on, the embryo is busily feeding on the limited food supply given to it by the cells which are not going to take part in its formation and which in birds represent the yolk of the egg.

In mammals it is relatively very much smaller than in birds but it is



FORMATION OF BRAIN

This series of diagrams shows how the complicated structure we know as the human brain develops from the simple neural tube in the embryo.

still called the yolk sac. This becomes smaller as the embryo becomes larger, until finally it is a quite insignificant little bladder attached to the embryo only in the middle, at what is ultimately going to be the navel of the baby.

Blood System of Embryo

By the time it is exhausted, arrangements have been made for a new food supply to the embryo. Its circulatory system being by this time differentiated from the mesoderm, the next step is to link this up with the circulatory system of the mother so that it can live through her organism. This connexion is effected by a spongy flat structure about the size of a dinner plate at birth, called the placenta, from the middle of which rises a twisted cord of large blood-vessels which runs to the umbilicus or navel of the embryo.

The flat surface of the placenta is attached to the wall of the now much-thickened womb, so that the contents of the one blood system can pass through the cell membranes straight into the other blood system. Only things in solution are so passed; the blood cells do not pass. This means that all foodstuffs and oxygen taken in and digested by the mother become available to the embryo in the "prepared" form in which they circulate in human blood.

When the embryo wants oxygen it takes out of the mother's blood the oxygen which has got into it from her lungs. When it wants to get rid of carbon dioxide, it passes its carbon dioxide back into her blood and she excretes it through her lungs. When it wants to get rid of waste products it passes them into her blood for excretion through her kidneys.

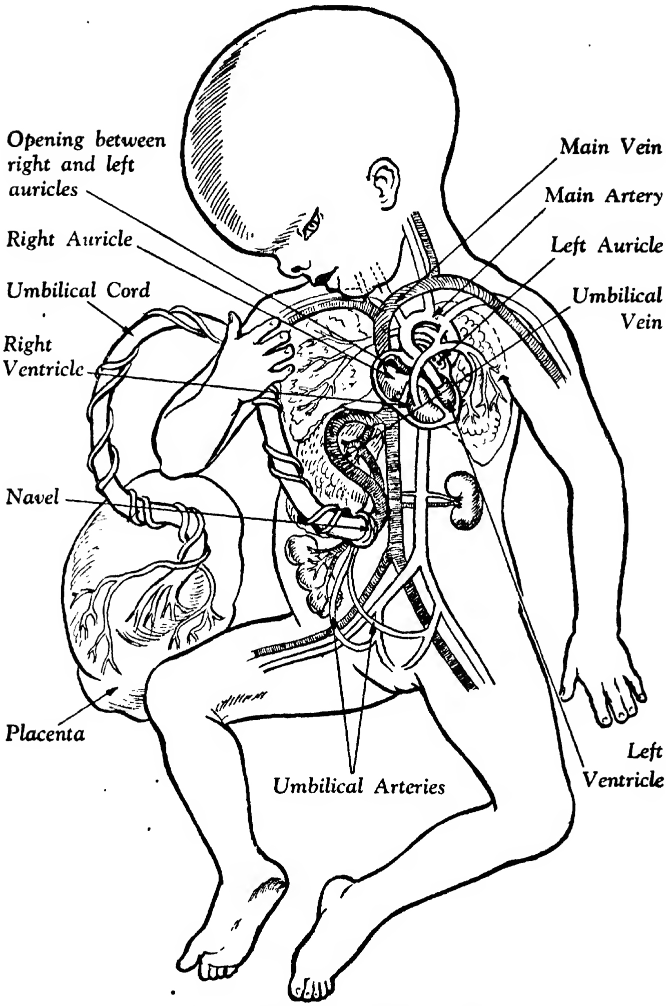
It is not easy to say what age the embryo is when various things happen to it, because the stages of development have had to be worked out from the embryos of animals whose mothers can be killed in order to get the embryo at the right stage, or else from eggs, which can be grouped, and each group incubated for a known number of days.

Appearance of Seven-week Embryo

An embryo at about seven weeks old has roughly a human appearance, although very unfinished, and from this time on it develops in the same kind of form, but with increasing size and increasing "humanity" in its appearance.

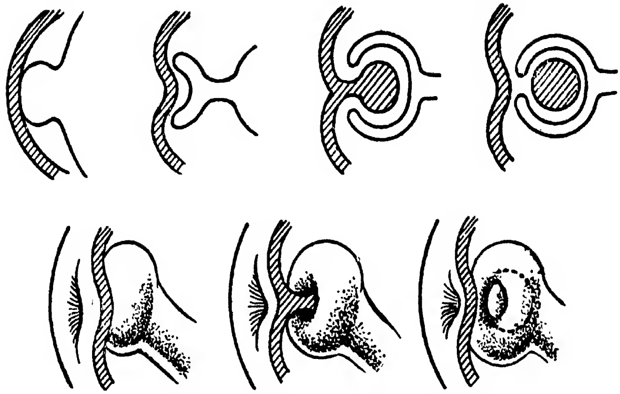
It has a large, clumsy head, a segmented body, tailing away to a thin hind end, an open "front" where the yolk sac joins on, looking like a balloon growing from its belly, and little blunt buds where the arms and legs will be. It is thin and jelly-like, with no firm pink and white flesh yet.

The head end grows very much faster than the rest, and so becomes disproportionately large. Although it has no face, it has a sort of expression because at a very early stage the ectoderm, where the future eye is to be, shows a thickening which looks like the round



CIRCULATION IN UNBORN BABY

Before birth, while the baby receives air and food from its mother's blood, there is an opening between the sides of the heart. This is closed at birth.



HOW THE HUMAN EYE IS FORMED

An outgrowth of the brain is pushed out to meet the place on the skin where the future eye is to be (diagram above left). This piece of brain then hollows to form a cup, into which the skin grows and becomes the lens of the eye, as shown in the diagrams above and the drawings showing the actual eye below.

expressionist eye often drawn by very young children.

The limb buds gradually grow out, the arms faster than the legs, and begin to show five divisions of fingers and toes at their ends. The embryo then bends on itself until it is curled up looking at its own tail.

Bone is always developed out of some other tissue, never direct from the mesoderm, so that either membrane or cartilage (gristle) is first produced from the mesoderm where the bones are later to be. In this membrane some of the mesoderm cells begin laying down lime salts in the form of microscopic spikes. These grow and join together to form a network, which is the basis of thin plates of bone. The bones of the skull are made in this way, and the rest of the membrane in which they were laid down forms the tough enclosing layers found on either side of adult bones, helping to protect them.

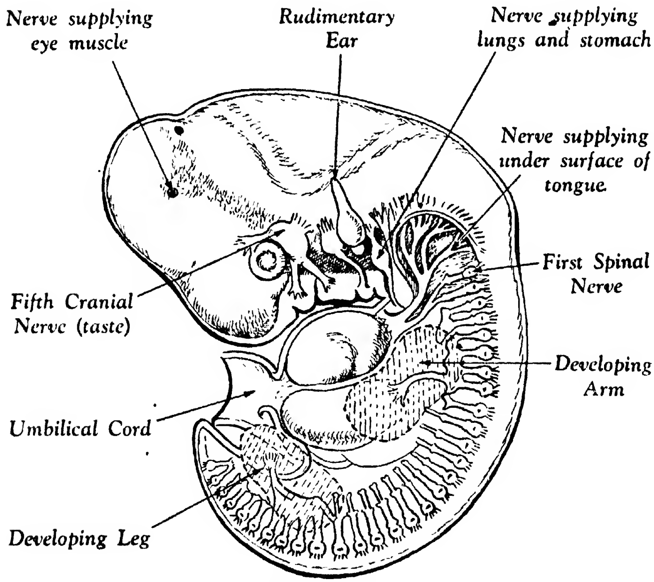
The long bones, like those of the arms and legs, are first formed from the mesoderm, not in membrane, but in gristle. Later the gristle cells arrange themselves in rows, and lime is laid down between them.

The vertebrae of the spine are pre-formed segmentally in cartilage round the notochord, which becomes completely buried in bone later on. From the lumps of bone so formed, processes grow up to meet round the spinal cord and enclose it in a firm bony tube. Between the segments bone formation is never completed and so the

vertebrae remain separated from each other by disks of jelly-like material very similar to mesoderm.

The human skull in its early stages is a mass of mesoderm surrounding the notochord and stretching beyond it to make a basis for the tissues which are going to form the nose. In this head mass there is no sign of segmentation. In it gristle is formed, as a flat or saucer-like plate at first, the sides and roof of the skull being still formed by a very dense membrane. In this membrane develop the flat skull bones which enclose the brain, and in the cartilage beneath develop the complicated bones of the skull and back of the nose.

The joints are the spaces of mesoderm left over between the rods of cartilage or plates of membrane which subsequently become bone. This mass of mesoderm may remain as a fairly primitive membrane, as is seen in the skull, where the bones are separated by a thin line of membraneous tissue, or it



INTERNAL STRUCTURE OF A MONTH-OLD EMBRYO

The spinal nerves and chief organs are already formed and the developing arms and legs are at this stage little blunt buds (indicated by shading). The head, with rudimentary eye and ear already evolved, grows very much faster than the rest and is therefore, disproportionately large in relation to the body.

may become gristle, as is seen in the front of the ribs, each rib being joined to the breastbone by a bar of gristle.

Thirdly, there may be an intervening bar of cartilage with a tiny hole in it. Whereas the first two allow of hardly any movement, when there is a small cavity in the gristle, a very slight amount of movement is possible. This is not a common kind of joint, but is seen in the union of the two hip bones in front. This joint is stretched to its uttermost at the time of childbirth, in order to increase the space through which the baby must pass.

Joints and Ligaments

Fourthly, the kind of joint familiar to most of us is formed by developing a cavity between the ends of bone, lined by a very smooth and delicate membrane which is kept lubricated by a special fluid. This, if the bones are the right shape, gives a very beautiful and freely moving ball or hinge joint.

To protect the delicate joint membrane, certain parts of the mesoderm around it become thickened to form tough cords or bands, running from one bone to the other. These are called ligaments. The joint is also protected by the muscles passing over it.

There are two kinds of muscle in the body: the voluntary, which we can control by will, and the involuntary, like that in the alimentary canal and lungs, which works without consciousness or will. The heart is a muscle which is half-way between the other two in appearance, although there is little evidence that it is at all affected by will.

All the muscles are formed in the mesoderm by a change in the shape of the cells so that instead of being roughly circular or star-shaped, they become drawn out into long spindles or fibres, bound up together. Each individual fibre and all the bundles of fibres are wrapped in delicate packing tissue called connective tissue.

The involuntary muscles are still obviously cells, although drawn out into very long, thin spindles. The voluntary muscles have taken the process so much further that they do not look like cells at all, but like bundles of strings with nuclei scattered here and there.

Blood-vessels and Blood Cells

The first blood-vessels are seen at a very early stage in the mesoderm, lying near its deepest part and against the endoderm. These first circulatory cells are round and soon begin to arrange themselves in cords. The cords grow and run together to form a dense network of canals. In the space in the middle of each lie some loose cells, which will become circulating blood cells.

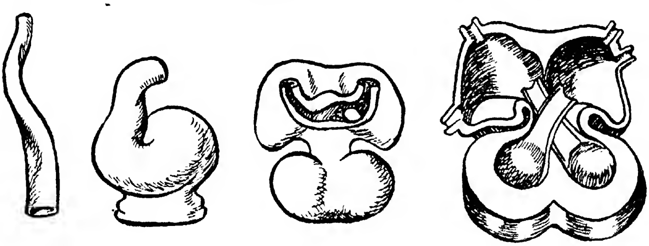
By further stages of the same development, a complicated network of blood-vessels is formed, running all over the embryo, and also out of the embryo through the old yolk sac opening to reach the placenta on the wall of the womb.

Certain organs are later set apart for manufacturing blood cells.

which are then loosed into the circulation. These organs include liver and spleen in the embryo, but the work after birth is mainly done in the bone marrow. From an early stage the blood-vessels divide into arteries, which take the blood from the heart to the tissues, and veins, which return it from the tissues to the heart.

The heart appears very early, when the embryo is still a flat streak on the yolk sac, and begins

There is, however, a stage in the embryonic development at which there are no lungs working and therefore the blood cannot be supplied with oxygen if it follows the adult route from the right side of the heart to the lungs. Thus, during the placental stage, there is an opening in the division between the two sides of the heart, and the blood which would go to the lungs is directed to the placenta instead. This opening is closed at birth.



DEVELOPMENT OF THE HEART

The heart appears and starts to beat very early in the life of the embryo in the form of a simple tube. This tube develops and as early as the fourth week begins to force the blood through the blood-vessels of the embryo. Diagram on right shows opening in the division of the heart which closes at birth.

as two bodies which later meet and fuse in the middle line. It is as if two tubes were formed and gradually brought nearer together until they combined.

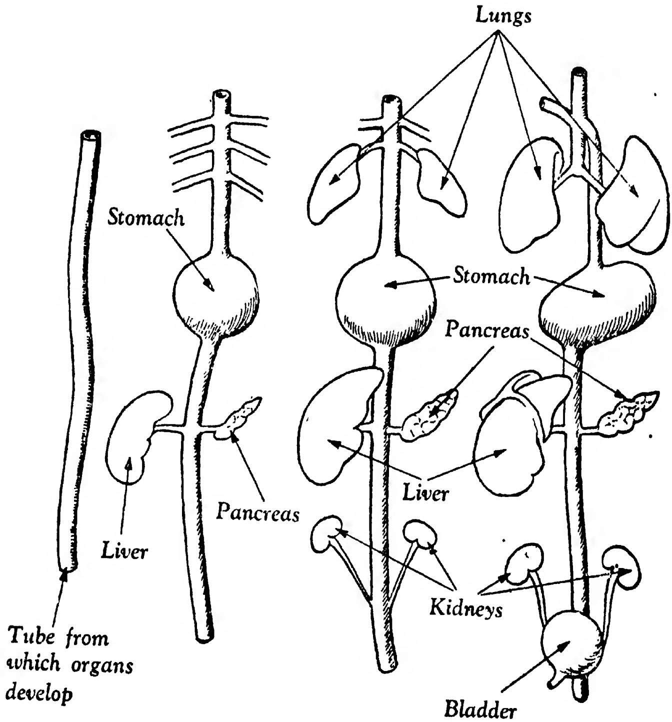
In the adult heart there is no communication between the right and left sides. All the blood which has returned to the right side of the heart goes out again from the right side to the lungs, and then has to come back from the lungs to the left side of the heart in order to go round the body again.

as soon as the lungs begin their work. The heart is first formed much nearer the head end than its adult position, lying in the future neck, and during development it gradually works backward until it reaches the chest.

The greater part of the digestive tract is formed by nipping off part of the yolk sac and turning it into the body of the embryo. Finally, the ectoderm grows over the endoderm tube, enclosing it within the body except for the navel opening.

The extreme front and back ends of the alimentary canal are not part of this endoderm tube, but are formed by pouches of the ectoderm, pushed in from the front and back respectively, which finally join on to make a complete tube from head to tail. The tube early shows a simple spindle-shaped expansion near the front end which ultimately becomes the stomach.

Before long, since the rest of the tube grows much more rapidly than the body of the embryo, the digestive tract has to curl up, in order to find room for itself inside the abdomen. Thus we get the closely packed coils of intestine.



DEVELOPMENT OF ORGANS.

The digestive tract starts as a simple tube, and this early shows a swelling which will eventually become the stomach. The liver and pancreas grow out from the tube, and later the lungs, kidneys and bladder develop from it.

The liver appears very early, at the age of about a month, as a groove on the under surface of the digestive tube. The endoderm cells lining this groove grow very fast and form a mass which sticks out from the floor of the tube. It becomes very large, and the little stalk showing how it originally developed becomes the bile duct, which runs from the gall bladder to the small intestine which is situated just below the stomach.

Pancreas and Kidneys

A little later than the liver, two or three more outgrowths appear from the roof of the digestive tube close to the liver stalk. These fuse together and grow until they form the pancreas (or sweetbread) which opens into the intestine close to the bile duct in the adult. The spleen is developed from the mesoderm, not from the endoderm, and appears about the fifth week as a local thickening.

The kidney and the organs of reproduction develop together from the mesoderm lying near the tail end of the embryo, which becomes heaped up into a ridge on each side of the middle line. It is a curious thing that three kidneys appear in succession: the first, nearest the head end, is never more than rudimentary in the human embryo, although its duct or canal leading to the outside persists and ultimately forms part of the genital system.

The second kidney develops a good deal during embryonic life, and then degenerates, while the third finally becomes the kidney of the baby at birth. The kidneys all first appear as rows of microscopic tubules which run at right angles to a long tubule forming a duct. The third kidney develops near the tail end, and gradually during development moves up to occupy the adult position in the loin.

The sex gland appears as a secondary thickening along the side of the kidney thickening of the mesoderm but, unlike the kidney, it begins nearer the head end and gradually moves tailward. In the female it moves down as far as the pelvis, but in the male it goes even farther and is accommodated outside the body shortly before birth.

In the male the duct of the first kidney forms much of the duct of the adult sex gland. In the female this duct disappears but the duct of the second kidney fuses with its fellow of the opposite side to form the womb. This duct in the male degenerates into a few rudimentary knobs without further development.

Excretory Organs

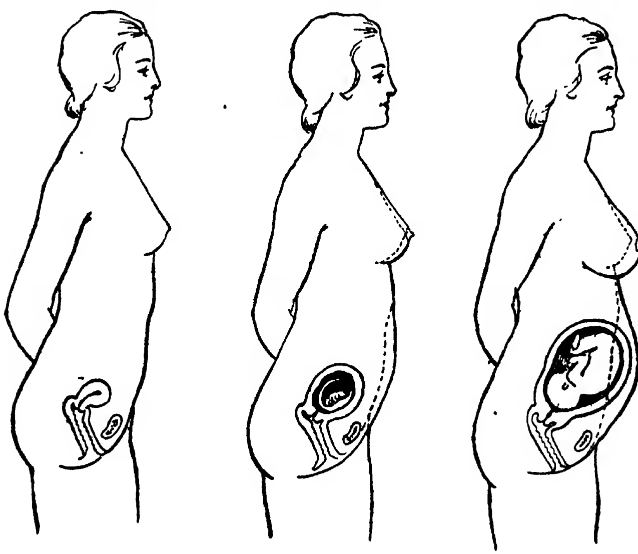
The first two kidney ducts open to the exterior in a shallow saucer-like depression which gradually becomes built up and divided by ingrowth of the ectoderm. The back part of it joins on to the back of the digestive tube, so that the rectum opens to the exterior by the back passage or anus. The front part of the depression grows into the embryo and joins the kidney ducts to form a storage tank, called

the urinary bladder, into which the kidney ducts, or ureters, open.

During all this time the developing embryo is very carefully protected from damage in a "water-bed," or bag of fluid, in which it floats. At first it is not nearly as big as the bag and may be almost said to swim about. When, at about the fourth month of its development, it is large enough to kick inside the bag, the mother often feels the impact of its movements against the inside of her abdominal wall and this is called quickening.

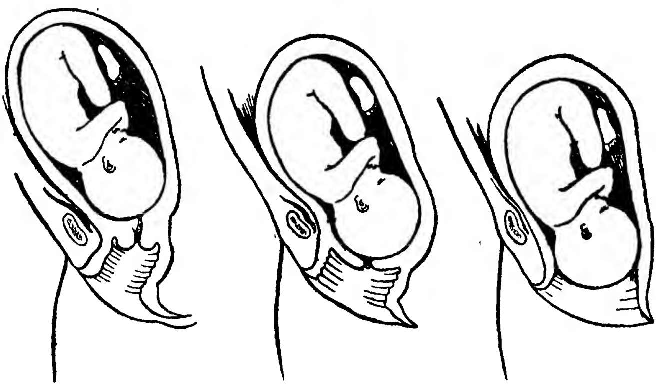
As it grows larger and larger, so, by one of the most extraordinary mechanisms of nature, the womb grows larger with it, until a small pear-shaped organ approximately three inches long, two inches wide and one inch thick, has become large enough to hold a full-term baby. The mother's other organs are skilfully packed away so that they can continue their function in spite of the pressure of this abdominal content.

Finally, the baby fits its bag of water and the womb very tightly and can no longer move round freely, although it can still kick and punch. The effect of this tight fit is to keep the baby in the position in



ENLARGEMENT OF WOMB AND BREASTS

By one of the most wonderful and complicated mechanisms of nature the womb grows with the developing embryo until it is large enough to hold a full-term baby. During this period the breasts also develop and increase in size.



PROCESS OF BIRTH

The baby's head is used as a piston when the process of birth begins, and the baby is pushed down at intervals until the mother's tissues are sufficiently stretched to allow its passage through the vagina to the outer world.

which it is wanted for the most successful birth. Occasionally it gets fixed in a wrong position, and the doctor has to help it out.

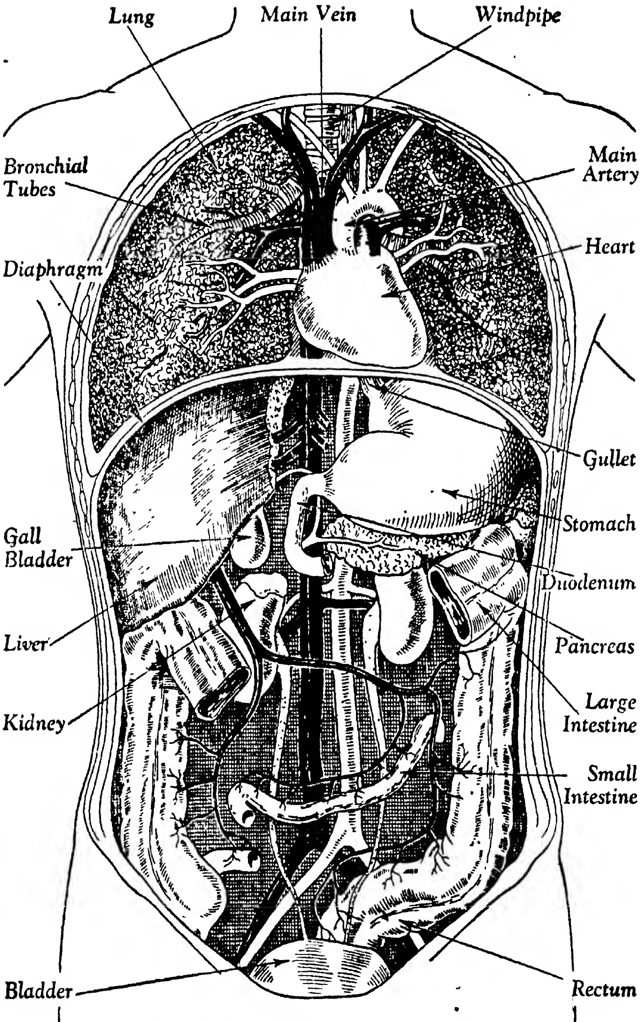
Nobody quite knows what gives the signal for birth. A number of factors have to be satisfied: the baby must be of a certain age and degree of development.

There may be changes in the placenta, so that it is no longer able to nourish the child, and there are certainly changes in the glands of the mother, so that the glandular balance which has kept the womb quiet and free from the monthly rhythm for nine months, is reversed and the muscles of the womb begin to contract vigorously.

The passage through which the baby has to come to get to the outside world is rather narrow, and the first problem is to stretch it so that the baby can slip through. For this purpose the baby is used like a piston and pushed down at intervals until the mother's tissues are sufficiently stretched to allow it to come through.

The baby's head is a better piston than any other part of it, and for this reason the normal baby is arranged head downward shortly before birth. Babies which lie feet downwards in the womb have a much more difficult birth.

When all the passages are sufficiently stretched to let the baby through without tearing, then the second stage of labour begins and the womb contracts much more vigorously and continuously, in such a way as to push the baby out. The placenta remains for another twenty minutes or half-hour, and then is expelled in turn.



PRINCIPAL ORGANS OF THE BODY

Compare this diagram with the frontispiece in colour, which shows the same organs and their functions in terms of the world of machinery.

CHAPTER TWO

HOW YOU GROW UP

Adjustment of breathing and blood systems after birth. First use of digestive system. Human milk. Growth by cell production. Teething. Walking and talking. Full development of reproductive glands. Maturity and middle age. Climacteric in man and woman. Value of diet and rest. Senescence and senility.

The moment before birth the baby is a slimy, doubled-up creature living in water like a fish, but different from a fish in that it does not take nourishment through its mouth and air through its gills. Everything comes to it through the placenta, which brings its blood and its mother's blood into such close relationship that food and oxygen can pass across the dividing barrier.

Similarly it has no excretions, but returns all its waste products to its mother's blood. It is a complete parasite. Yet it has all the mechanisms ready to respond to the challenge of birth, which turns it into an independent, even if relatively helpless, individual.

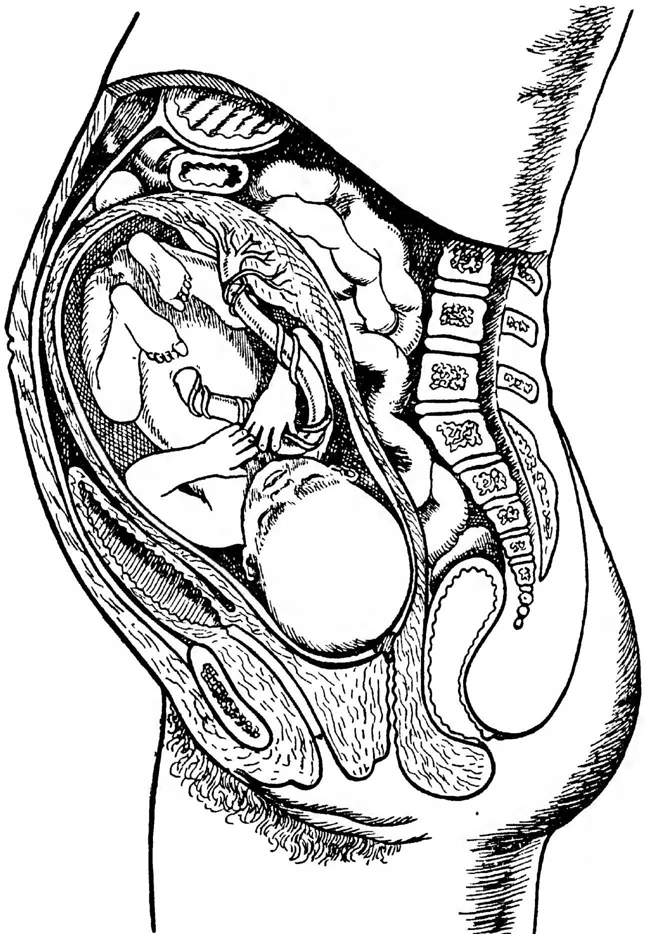
Since the human organism cannot exist for more than a few minutes without oxygen, the breathing system is the first to be brought into action. Nature arranges that a deep breath shall be stimulated by cold on the skin. You can test this by trying to breathe quietly and normally under a sudden cold shower or cold plunge.

The sudden feeling of air on a skin which has never known anything but the body-warm waters of the womb gives the baby just such a shock, and if he is a normal baby he opens his mouth and takes a great gulp of air, and then, having started the habit, he just goes on breathing. Very often when he opens his mouth he makes a noise, and that explains the new-born baby's first cry.

Once breathing starts it does not stop; the next thing is to cut the baby off firmly, finally, from all the source of life he has known so far: the placenta. He is still linked to it by the cord that runs from his navel, but his first breaths have readjusted the blood system so that it begins to take oxygen from the lungs instead of from its mother's blood.

Thus, the blood running along that cord has lost its usefulness, and in about half an hour it will be dead blood, for the placenta will be separated from the inside of the womb, and there will be no further supplies from the mother.

Therefore, with animals, the mother instinctively bites through the cord when her babies are born, and the human baby has the cord cut and tied. Then he can look after himself for a number of



BABY IN WOMB SHORTLY BEFORE BIRTH

Before birth the baby breathes and receives its nourishment from the blood of its mother through the umbilical cord, which runs from the navel to the placenta attached to the wall of the womb, as seen in the above diagram. At the moment of birth it begins to breathe through its own lungs, and with the expulsion of the placenta it is cut off from its previous food supply.

hours, because all that is needed is rest after such strain and effort.

Soon after his birth, the baby is bathed in order to remove from his skin the slimy coating that made him so conveniently slippery while he was being expelled from the womb.

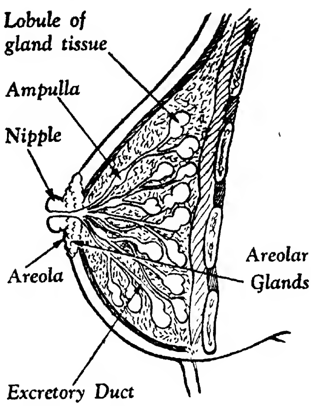
About this time too, he begins his first experiments in excreting from his bowel. During his pre-natal life he swallowed some of the water surrounding him, and his liver began to practise making bile; also some of the other digestive glands started work tentatively. He thus has some material in his bowel to get rid of. This is called meconium, and is dark green because so much of it is made of bile.

His kidneys started working some time before birth and poured their excretion into the water around him, but now their activity is greatly increased.

The baby during these early days spends most of his time sleeping off the ordeal of birth.

Human Milk

In fact, Nature provides no food at all for him during this time, for the mother's breasts contain no milk until the fourth day. The habit of taking liquid by the mouth, however, needs establishing, and Nature provides something very important before the milk comes in. This is a colourless fluid which is derived from the mother's blood; it has little or no food value, but is full of the protective substances that keep the mother healthy.



MILK GLANDS

On the fourth day after birth the glands of the mother's breasts begin to manufacture the milk which is to nourish the baby. The gland tissue and ducts, which run together at the nipple, are seen in this cross-section.

Thus, the baby, who is so vulnerable to the surrounding germs until he can mobilize his own fighting resources, gets this passive protection from the day of his birth. His instinctive sucking at the nipple not only teaches him to feed himself in this new way, but also helps to stimulate the milk production.

Mother's milk, the proper food for all new-born mammals, is produced by the two special factories called the breasts, or mammae. It is made out of the blood, from which certain special contents are taken, and made up into the whitish fluid that we know so well in the form of cow's milk.

The milk of each animal is just perfect for the baby animal of that kind, so that milk from another animal is never quite so good, though most babies manage to thrive on it. Many human babies have grown strong on the milk of cows, though the development of the calf is a very different process from that of the human baby: for one thing, the calf grows much faster, and therefore cow's milk is too strong for babies, and must have water added to it.

Feeding of Baby

Mother's milk contains everything that the baby needs except iron. Because it does not contain iron the baby is born with a special store of iron in its liver, intended to last it until the breast-feeding period is over. This need for iron is one of the reasons why babies who are kept too long on the breast become anaemic and do not do so well as those who are weaned at the proper time.

In the artificial conditions of city life, however, babies may get insufficient sunlight, and then they may, even if breast-fed, be a little short of vitamin D, which is produced in the skin when the sun plays on it. Therefore it is usual to advise that babies should have cod-liver oil in winter, even if fed on breast milk.

When they are fed on cow's milk, which has to be heat-treated to free it from germs, they are likely to lack vitamin C, which is easily destroyed by heat; hence the advice to give bottle-fed babies orange or tomato juice, as well as their milk and cod-liver oil. When on the fourth day the breast begins to give him milk, the baby's digestion makes its first display of activity. From then on, he displays interest: he is hungry and likes being fed; he learns that in order to satisfy his hunger he has to display behaviour; that some behaviour is more satisfactory than others.

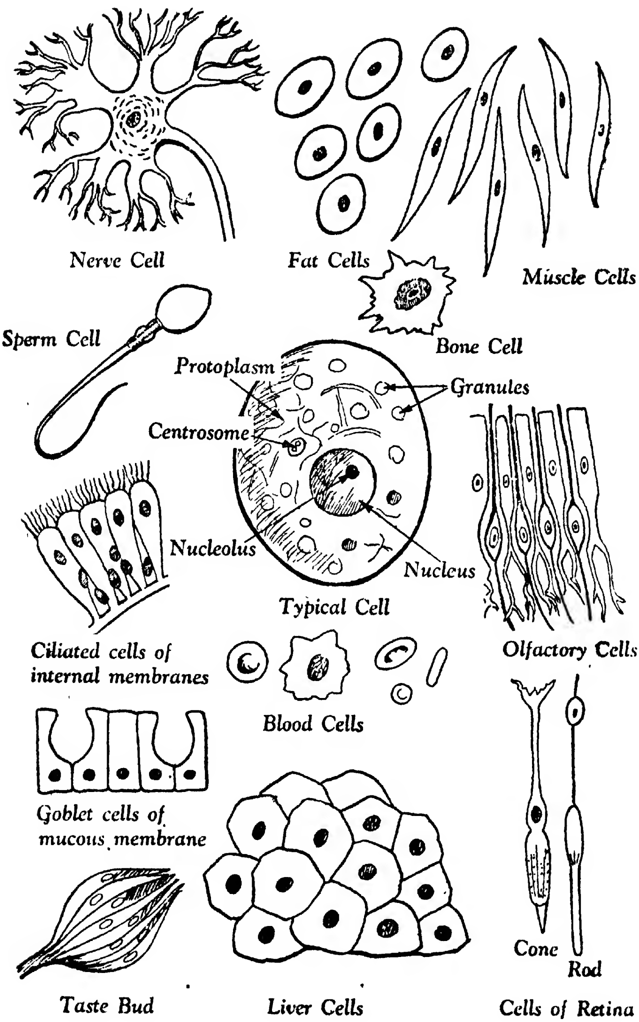
Day by day his relationship to the world around him increases in extent and variety. He begins to pay attention to the messages his eyes and ears are sending to his brain, and to put two and two together, so that he recognizes familiar people and objects, and makes some sense of the kaleidoscopic scene around him.

By the time he is four months old he will follow moving things with his eyes, lift his head up a little, especially when laid face down, smile, and grasp objects which are placed in his hand.

Cell Growth

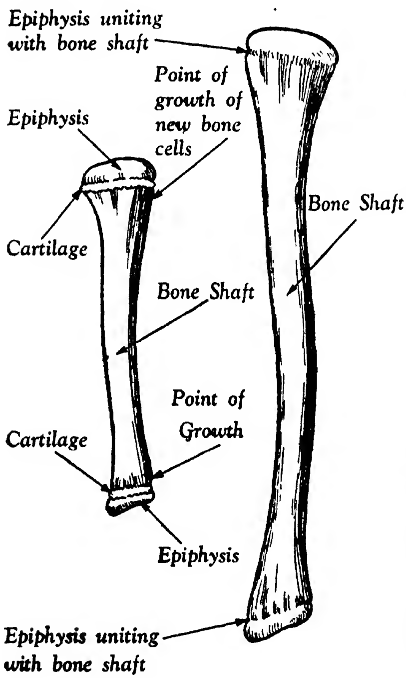
His mental problem for many months is that of adapting himself to the world. His physical problem is simply one of growth. He has to grow relatively very fast, making new cells by the million all over his body, but especially in the lower half, which grew relatively less fast before he was born.

These millions of cells are of many and various kinds, each kind with a different function. Some are shown on the opposite page.



SPECIALIST CELLS PRODUCED IN THE BODY

His bones, which began as cartilage formed from the mesoderm, play an important part in this process of growth. The bulk of a bone is built from one expansion point in the cartilage, the laying down of lime salts proceeding up and down the length of the future bone.



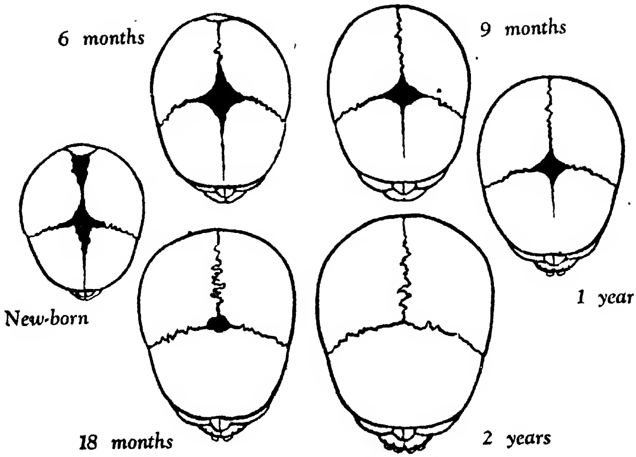
HOW BONES GROW

Between the main bone and the caps (epiphyses) at each end is a ring of cartilage, which is eaten up by bone gradually from the age of fifteen until about twenty-five years of age. When this process has been completed growth inevitably stops.

All through childhood and adolescence, however, there is still gristle in the bones made in cartilage; it remains as a cap at each end of a long bone, and round the rims of flat plates of bone like those of the hip. This makes it possible for the bones to go on growing: they grow by extending farther into the cartilage.

Small centres of ossification, or bone formation, later appear in the caps at each end of the long bones. These are called epiphyses. They remain separated from the main bone until all the cartilage has been replaced by bone, and then growth must stop. The final eating up of cartilage by bone begins at about fifteen, but is not complete everywhere until about twenty-five years of age.

The bones of the skull are formed, not from cartilage, but from tough membranes. Lime salts are deposited between layers of these membranes and thin plates of bone are produced. At birth there are gaps remaining between these plates of bone, known as fontanelles, which help to make easier the passage of the baby's head. The process of birth would be a very difficult and painful operation, and probably would be quite impossible in most cases if the plates of



CLOSING OF THE FONTANELLES

At birth there are gaps in the bones of the skull known as fontanelles. They gradually close as the bones of the skull grow, and by the age of two years have disappeared. The diagram shows how the skull of a baby looks at birth, six months, nine months, one year, eighteen months and two years.

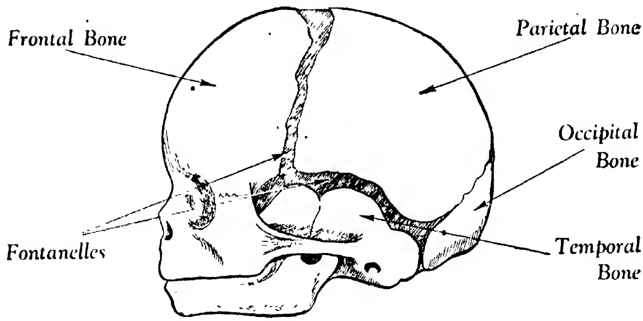
bones forming the skull of the unborn baby fused together before birth into solid bone.

The fontanelles gradually disappear after birth as the bones of the skull grow and join together, and the final gap is completely closed at some time in the second year of life.

Between six and nine months of age a special kind of growth engages a good deal of attention: cutting the first tooth. This appears in the lower jaw, under the tongue, so that the nipple does not get scratched by it, for at the time it appears the baby is normally still on the breast.

Its fellow comes next, and then usually the upper two teeth on each side opposite, so that when he wants to bite off something he has four teeth facing four teeth, to make a good cutting surface. Next comes a back tooth, with its three fellows, so that baby is ready to chew anything hard that he gets hold of. Last of all are the eye teeth and the second grinders, from eighteen months to two years.

Some time about his second birthday he will have his full set of twenty milk teeth. While it is a very good thing to keep these teeth cleaned regularly with a soft brush, their fate is sealed before they come



SKULL OF A NEW-BORN BABY

The skull is formed of a number of thin plates of bone which develop, not from cartilage, but from tough membranes, between layers of which lime salts are deposited. The principal bones forming the skull are shown above, with the fontanelles which assist in the easier passage of the baby's head at birth.

through the gum, for they have been formed inside the jaw and will be strong and hard if the mother's diet during her pregnancy contained enough of the necessary mineral salts. If not, they are likely to decay, however well the baby himself is fed.

Underneath these milk teeth, deep in the jaw, the permanent set is being formed while he is a baby, and their fate in turn depends largely on the right diet in the early months of life.

The first of them will come through behind all the milk teeth: the first permanent grinder, at about six years. Then the new front teeth begin to push out the baby ones, and the eight-year-old begins to show gaps where the old teeth have been dislodged while the new ones have not yet had time to grow and fill their places.

Animals wean their young when the baby teeth begin to bite and hurt the breast, and this happens to human mothers when the baby is about eight months old. Weaning may cause great offence to the baby if he is the kind of person who likes to "stay put" and have things as they always were. As the sentry in *Iolanthe* tells us,

Every boy and every gal that's
born into this world alive
Is either a little Liberal or else
a little Conservative.

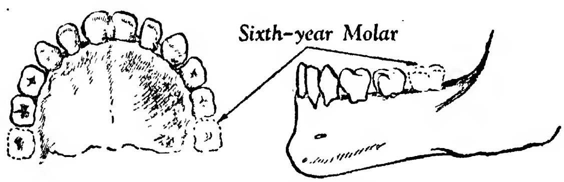
The little "conservatives" want to go on getting food in the easy, babyish way; more progressive little "liberals" are eager to taste new foods and new adventures and give no trouble. A good deal depends on whether the mother is glad for her baby to grow up, or prefers it to remain a baby. If both baby and mother are keen to go

forward, weaning is usually no trouble at all.

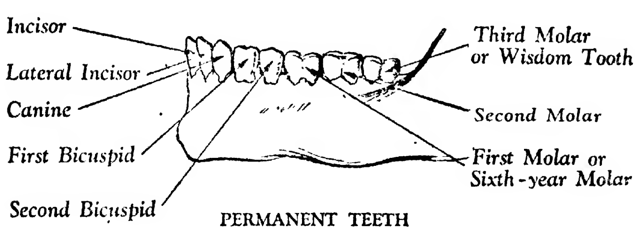
Two other special adventures of the baby are talking and walking, though the ages at which they begin vary a great deal. Generally the lower part of the body has done enough growing in about eighteen months for it to be able to support the rest, and the struggle for balance known as "learning to walk" begins. The arms are strong enough from birth, and any new-born baby can hang for quite a long time from its hands. Talking usually begins at about a year, and short sentences can usually be composed at about two years.

For some years after weaning the child has no physical crisis. He goes on with his processes of growing and adapting. He works hard with his brain and his body, and displays amazing energy in both directions. To the child what we call "play" is work, and real, good work too, teaching him the lessons he must later apply in adult situations. The habits he forms in the nursery are likely to dog him throughout his life.

To do all this work properly he needs plenty of the right kinds of food, plenty of sunlight, fresh air, and sleep. The six-month-old baby will sleep eighteen hours out of the



FIRST SET OF TEETH SHOWING THE SIXTH-YEAR PERMANENT MOLAR IN POSITION



PERMANENT TEETH

MILK TEETH AND PERMANENT TEETH

The first teeth are cut at about six months and by the age of two the full set of twenty milk teeth have appeared. Underneath these the permanent teeth are being formed and will later push out the baby ones. The first permanent tooth, however, comes behind the milk teeth at about six years.

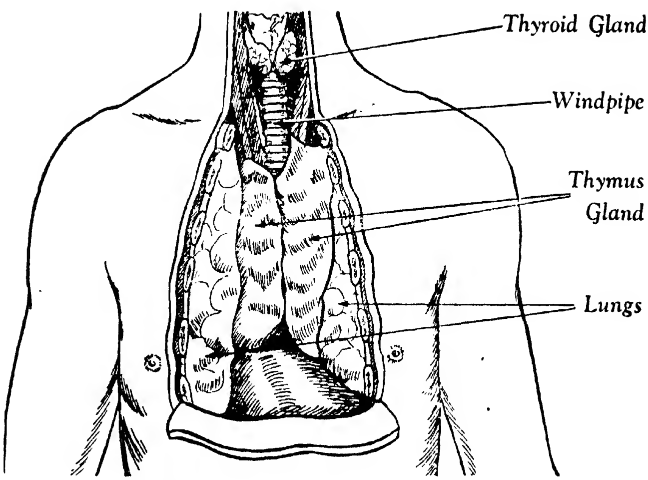
twenty-four; the six-year-old child should sleep ten or twelve hours. The ten-year-old needs ten hours, and the fourteen-year-old nine hours.

The new-born baby has a small gland behind the upper part of the breastbone. This is called the thymus gland and at birth it weighs only about a quarter of an ounce. It increases rapidly in size in the early years and reaches its maximum at about the age of five.

The thymus gland seems, in some mysterious way, to be connected with the sex glands. As they develop the thymus gland gradually declines, until in the adult it has practically disappeared.

Thus it becomes very much smaller when the child reaches the reproductive stage, that is, when the genital organs are perfected. This is the next most important change after birth.

At birth the boy normally has his reproductive glands down in their special bag, the scrotum, though occasionally they come down a little after birth. These organs are fully formed, but remain inactive until the phase of puberty,



THYMUS GLAND OF A CHILD OF TWO

The thymus gland seems in some mysterious way to be connected with the sex glands, for as they develop it declines. At birth the thymus gland weighs only about a quarter of an ounce, but it increases very rapidly in the early years and its size in a two-year-old child is shown in the above diagram. The thymus gland reaches its maximum at the age of five years, and at puberty begins to get smaller until in the adult it has practically disappeared.

which may be any time from ten years on, but it usually occurs between the ages of twelve and fourteen years.

The fact that the male organs have developed their full function is not marked so much by any change in them—though they become larger—as by the changes which are produced in other parts of the body as a result of pouring into the blood stream the special fluid which the sex glands manufacture for the purpose.

Male Changes at Puberty

This fluid is called their internal secretion, and its task is to ensure that the male activities are performed by a male body. It causes hair to grow on the chest, in the armpits, between the legs, on the face, and sometimes on the big toe and the backs of the hands.

All these hairs do not appear at once; the hair under the arms and in the crutch appears about the time of puberty; the other growth is usually delayed for a few more years. As the internal secretion of the male gland completes its work the body begins to take on the special male shape, with strong chest and shoulders, and the voice breaks, to assume the male depth of register.

At the same time the gland produces an external secretion, which is the fluid which carries the actual male cells, or spermatozoa. This is built up slowly by the gland, and stored in little sacs provided for the purpose.

Even more dramatic are the changes in the girl. While the boy has only to manufacture millions of special reproductive cells and the apparatus for conveying them to the female cell, the girl has to arrange to receive these cells, to produce reproductive cells to meet them, and to house the growing baby for nine months.

Life is much simpler for the fishes. All they have to do is to drop their reproductive cells into the water, just as if they were excreting some waste product, and hope that Nature will arrange for the male and female cells to meet and develop new fishes.

First Land Breeding

When land life began, this problem became serious, and the first land animals had to return to the water to breed—as frogs do still—because if they dropped their reproductive cells in this careless way on land, the cells dried up, or were blown away and destroyed.

If life was to be lived on land, free of the need to return to water for breeding, something had to be done about it. The first land animals to solve this problem were the lizards, and the birds followed them closely. They devised a plan for wrapping the fertilized ovum round with enough food to last it until the baby could look after itself, and then enclosing the whole mass in a hard shell, so that dryness and warmth did it no harm.

This made a demand on the male and a demand on the female. The

male had to develop an organ which would push his seed right inside the body of the female, so that it met her reproductive cell before the shell was put on. Thus developed the male organ or penis, which can thrust right up the female passages and deposit the spermatozoa safely near the female gland which produces the female reproductive cell, in order to ensure union.

Reproduction by Egg System

On the female the demand was to lengthen and complicate the passages between her gland and the exterior, so that when the male cell had met and fused with her cell, the resulting fertilized ovum should, on its way to the exterior, pass along special tubes which wrapped round it all the foodstuff and shell-stuff necessary for its safety.

The familiar hen's egg is just one microscopic fertilized ovum, surrounded by enough food to keep the chick alive and growing for three weeks, until it is strong enough to peck its way out and look after itself. This was a splendid plan at first, and the reptiles and birds multiplied and filled the earth.

Unfortunately there came a great Ice Age; all the vegetation on which the reptiles lived became covered with ice, and they were threatened with starvation. There was nothing to eat but all those eggs lying about in the sand and in shallow nests. Life became one great egg hunt, and those who found and ate their neighbours' eggs helped to build the tombstone that lies over the great age of the reptiles. They exterminated each other.

Birds, with nests in trees, were better off, but the land animals died out—all except some queer, very despised creatures who for some reason had tried out an entirely new scheme.

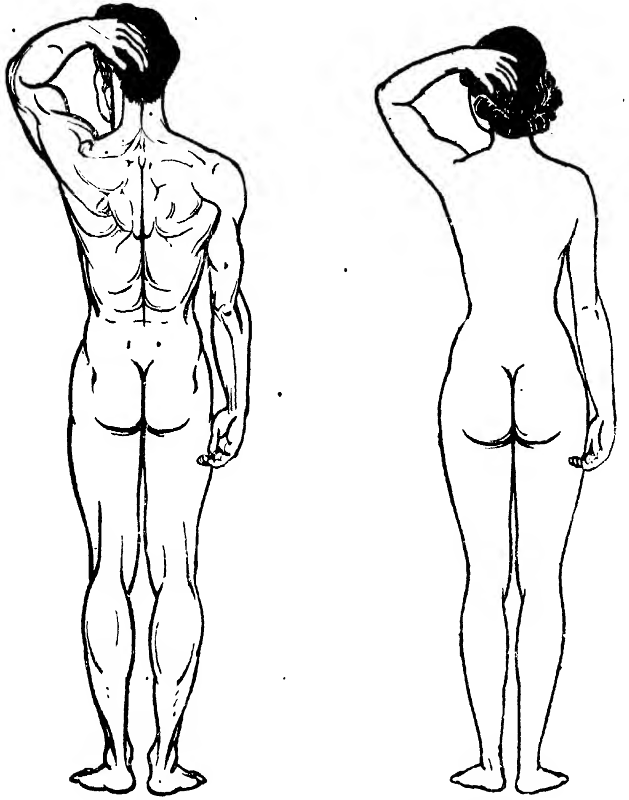
These animals, or mammals, had, among other things, decided to keep their bodies at a constant temperature whatever the weather, and had devised a complicated heat-regulating system, including the use of fur coats.

When a reptile's world goes cold, he goes cold too, and for this reason snakes curl up and go to sleep in the winter; but when a mammal's world goes cold, his temperature remains the same. The Ice Age, therefore, did not appreciably affect the mammals.

Reproduction in Mammals

But they had done more than protect themselves against cold; they had abandoned the egg system altogether, and so ensured the future of their race. They had evolved a plan for keeping the immature baby inside its mother's body until it could look after itself, instead of turning it out inside a shell.

The first attempts were rather tentative, as shown by the kangaroo today: the baby was born quite immature and tiny, picked up on its mother's tongue, and put into a pouch on her abdomen, where it grew to maturity. Later mammals did better than this, and arranged



MALE AND FEMALE FORMS CONTRASTED

At puberty, not only do the genital organs develop their full function, but other changes are produced by the action of the glands, causing the male and female bodies to assume their typical shapes and characteristics.

that the baby never left the mother's body until able to stand and feed.

Thus the female had to develop from the food and shell-producing tubes of the reptile stage a very wonderful hollow organ which could expand to the size of a full-term baby of her species, and could nourish it from her own blood until it reached the outside world.

The female organs of a mammal finally came to consist of an ovary,

or gland producing the reproductive cells and the internal secretion which makes the body feminine; a tube leading from the ovary to the womb; a womb to hold the child; and lastly, a short birth passage through which the child passed to the outside, and up which the male can thrust his organ for fertilization purposes.

The internal secretion of the ovary, like that of the male gland, begins at puberty, and produces the female shaped body: the soft curves and the fat deposits that make a woman look different from a man. As in the man, it causes the development of hair in the crutch and armpits, but it does not produce hair anywhere else, nor does it produce any change of voice.

Process of Menstruation

It is the womb which produces the most dramatic outward sign of puberty in the girl. The process of nourishing a child inside it demands a regular building up of the lining. In humans this preparation takes place every four weeks; in other animals at longer intervals.

The whole womb is built up, so that it has a special thick, spongy lining, rich in blood supply. When the lining is ready, the reproductive cell leaves the ovary and travels towards the exterior. If it meets a male cell on the way the fertilized ovum burrows into the special cushion provided and pregnancy begins.

If it does not meet a male cell, it goes on and is lost outside. Then all the preparations are wasted; the thick lining is shed, a lot of blood comes away with it, and the whole cycle starts once again. This periodic shedding appears as a monthly loss of blood which is known as menstruation.

Maturity and Parenthood

From the time that the changes of puberty have become established, the man and woman enter on a period of full reproductive power which is associated with the fullest expression of the inborn drive to life in this world.

They both establish themselves as citizens and parents, and if their activities can be ascribed to one leading purpose, that purpose is the care of the young child and the provision for it of a good background from which to start its own life. Home-making and success in business both contribute to this purpose.

Biologically speaking, therefore, the age of the youngest child is an important factor in bringing this phase to its end. Since, ideally, parents should be about twenty to twenty-five years older than their children, the youngest child may be said to reach the age of eight or ten when the parents are between thirty-five and forty.

Of course, in modern life there are more exceptions to this rule than examples of it, but it is a factor to be used in assessing the beginning of that very vague period called middle age. When the youngest child is old enough to go

to school and to learn more from his contemporaries than from his parents, then there must inevitably be a change in the biological drive expressed in the period of maturity.

> A mother aged thirty-five, whose children were then twelve, ten and eight respectively, began to be obsessed by fears of death and a sense of unreality. Her kind friends said: "Forget all about it; stamp down these stupid or wicked thoughts; think of your duties towards your children." Her unkind friends said: "Barmy!"
>
> But she went to a psychiatrist who said: "Of course! It is quite right that to some extent your children should leave you, though without losing you as their background; and since you have been entirely devoted to them ever since they were born, you must develop a new kind of approach to life. That means that, in a sense, a new you must be born. All birth means death. Therefore the old you—the you that lives only for the children—must die. I am very glad you have realized it so clearly in good time, because now you can experience this death and new birth without too much difficulty, and you will not hang round the necks of your children and spoil their future."

A famous psychiatrist once said that his task with every patient over thirty-five who came to him was to prepare them for death. To those who regard death as an end rather than a beginning this may sound harsh, but indeed it has a good deal of wisdom in it.

Somewhere between thirty-five and forty-five there comes a watershed which marks the end of the drive into this world and the beginning of a new attitude to life, an attitude concerned primarily not with the material world and the children but with the non-material world and the future to which an individual goes when his body is no longer vigorous and pre-eminent.

This watershed or plateau may be said to extend into the middle forties; and when a man has reached fifty or so, he is usually well over the edge and going down the farther slope, which grows steeper and steeper as it nears real old age and senescence.

Keeping Young

Yet, as is obvious when we consider the many cases of people who are "wonderfully young for their age," there is really no reason why the plateau should not be of far greater extent than it normally now is. If the individual takes stock of his material bodily possessions and powers in good time, and makes a deliberate effort to preserve them in as good condition as he can, the flat hill-top of middle age, with its views back through memory to youth, and its forward view into a green old age "lovely as a Lapland night," may well be extended into the sixties and seventies. But this cannot be achieved without sacrifice and effort—things, in themselves, good for mind and body.

The wise men of the past have mostly been in accord in attributing many of the disabilities of age to the excesses of youth. This is very likely true; but when one has reached middle age there is nothing to be done about it. What can be done, however, is to make sure that these excesses are not persisted in. We cannot escape payment of bills already incurred; but we can resolve not to incur any fresh ones, or at least none that cannot be met.

Adaptation to Middle Age

Adaptation to the second half of life is, therefore, just as important and almost as difficult as adaptation to the first half, and most of the troubles of middle age and later life result from the failure to realize this.

Thus it is a great advantage to begin the preparation early, when the personality is flexible and still able to receive new ideas and develop new responses, and it is worth while to put the onset of middle age at the relatively early point of thirty-five.

There will then be no physical changes to make the adaptation more difficult, and the directing of thoughts towards what is to come should be smooth and successful. If it is postponed until the last minute and this change is tackled at fifty, then many difficulties and some disasters will follow.

One way of marking the difference between the two phases is to say that up to maturity the drive is toward material things and physical self-expression in a material world; whereas in middle and old age it is toward spiritual things and self-expression in a cultural sense.

Yet another way is to say that in the second half of life the qualities usually regarded as characteristics of the opposite sex have to be developed.

Nature shows this tendency even if there is no co-operation from the individual. How often has it happened that a gallant subaltern has married a sweet clinging young thing, only to find, after fifty, that she has become the "Colonel of the Regiment" and he a "regular old woman." When this happens without the help of the conscious will and understanding, it is bound to happen badly.

Desirable Qualities to Acquire

The qualities shown by a female "colonel" and a male "old woman" are never good male or female qualities, but if from early middle age onward the man realizes that he must—for example—add to his masculine strength and logic the feminine qualities of tenderness and sympathetic understanding; if the woman realizes that she has to learn masculine qualities of clear thinking and direct approach to public work, then both can make their contribution in the second half of life with benefit to themselves and the community.

For the woman, the end of the period of maturity is marked dramatically by the process known

as the change of life. This usually occurs between forty-five and fifty, but may be five years earlier or later. It is caused by the abandonment of the reproductive function by her sex gland and her womb. No longer is an ovum released each month and no longer is the womb prepared for its reception. Therefore the monthly periods cease.

This is a normal process, not attended by any serious unpleasantness unless there is some obstruction to the maturing processes of the mind at this stage. A woman who is not willing to go on to the next phase of life may suffer many physical and mental discomforts. But if she has prepared herself in advance and accepted the birth of a new personality in herself, then her physical changes will not give her any trouble.

The loss of activity in the sex gland throws out of balance a very complicated interacting system of all the glands, and certain other glands become more important in her make-up than they were when the sex gland was in full activity (see Chapter Eight). This is the physical basis of the development in her of more masculine qualities.

Male Climacteric

In the man the change is not so dramatic, although the "male climacteric" has been described as occurring between fifty and sixty in man, and, very gradually, the power to reproduce becomes weaker. Although it is extremely rare for a woman to conceive a child after her periods have stopped, a man may beget one even after the age of seventy.

Nevertheless, the demand of nature for a change in the personality is as great on the man as on the woman, and failure to pay any heed to it may have distressing results, particularly in civilized communities where too much stress is laid on the importance of the material world and achievement by material means.

Adjustment of Diet

One of the features of the change of life in both sexes is an alteration in weight, and both sexes tend to deposit fat. This is never a very healthy sign, although many people survive it without serious consequences, and the answer to it lies once again in early co-operation; reduction of sweet and fatty things and increase of salads and fruit in the diet, and the maintenance of steady, moderate exercise from early middle age onward.

Indigestion is another disturbance that may appear for the first time, and is closely associated with the mistaken tendency to continue eating the same food at a time when a change ought to take place. Irritability, depression and other mental disturbances are all the result of a lack of understanding of the transition period and unwillingness to accept the push given by nature into the new life.

Apart, however, from the loss of sexual function in the woman, there is no bodily change which regularly

and normally marks the transition from maturity to middle age.

That is to say, there is no change which, like puberty, is inevitable and obvious. But, in the male, at any rate, there are certain signs which cannot be disguised or unnoticed, and these frequently appear long before their appointed time. Too often, when a man should still be only fully mature, he shows these signs; and the experienced eye can tell that they are due, not so much to increasing number of years, as to the use made of them.

A man may be bald and short-sighted, and his senses less acute; he may have stiff and enlarged joints and his movements may be growing clumsy; he may lose his teeth and get fat and soft—"come rapidly to the front." When, in addition to all this, he is habitually constipated, he presents a picture of premature decay which is frequently his own fault.

Orderliness in Habits

As has been said, prevention in this matter is better than cure, and the treatment of all these unnatural symptoms should be begun quite early in middle life. At this time, personal inclination is no longer an entirely safe guide to what the individual should do, eat or drink.

A certain amount of deliberate orderliness must be established in the daily habits, and these habits must all take account of the importance of preserving the balance of the endocrine system—that elaborate organization of glands and glandular secretions the knowledge of which is a comparatively new thing.

In the matter of diet we must remember that it is not good enough just to cut down the food bulk; not good enough to think only of proteins and fats and sugars and starches. Certain salts are just as important as these; and all these things must be in a certain ratio with one another. It is not enough to think of foods merely in calories, as some dietitians have suggested. Nor can we rely upon our present instincts, which have become attenuated in the course of generations of so-called civilized life.

Primitive Man's Diet

To quote the late Dr. Leonard Williams: "When the *genus homo* was created or evolved he was placed in a milieu where he could find his own sustenance, and this he found in roots and fruit and herbs and dairy produce, locusts and wild honey. If he ate flesh at all, which he probably did, he ate it raw. Now in order to avoid the toxins which trouble our large intestine and ultimately poison our endocrine glands, we must learn our lesson from primitive man."

As the endocrine secretions influence nearly all our bodily and mental activities, so the vitamins appear to influence the endocrine glands, and we have lately discovered that perfect health is impossible in the absence or lack of the vitamins. This does not necessarily mean of the vitamins

in general, but of each of many kinds of vitamin. We have already learned the importance of vitamins A, B1, B2, C, D, E, F and K.

Therefore, unless we carry round with us in tablet or capsule form a whole set of these vitamins synthetically made and prepared, and supplement our ordinary haphazard meals with them, we run physical risk. A far simpler everyday method is to see that our daily diet contains a certain amount of "natural" food: vegetables and fruit in an uncooked state, dairy produce such as milk and eggs.

We must remember another thing: primitive man, in order to get his natural food, had generally to take a good deal of active exercise. Therefore, in middle age, whilst avoiding, if we can, overwork, both physical and mental, we should exercise up to our real capacity both mind and body every single day of our lives.

Importance of Sleep

The effects of sleep on the assimilation of food were investigated some forty years ago by Dr. George Oliver. He showed that during sleep the tissues are irrigated with lymph, a very large proportion of the whole amount of lymph poured into the tissues in the twenty-four hours being sent during a normal night of quiet sleep. Sleeplessness produces a greater degree of emaciation than does actual starvation, and does it more quickly. The artificial deprivation of sleep, which is a feature of the evil "third degree" questioning of suspected criminals, gives rise to emaciation to a surprising extent and in a surprisingly short time.

When the tissues are filled with lymph they give out their waste materials, which have to be collected and excreted during the hours which immediately follow sleep. A light—indeed a very light—breakfast is therefore physiologically sound; and ideally it should consist of fruit and milk, or some other simple combination of raw food with dairy produce. Even this change from the usual heavy English breakfast will be found to lessen considerably the tendency to "middle-age spread."

Midday Siesta

There is a good deal applicable to middle age in the Roman habit of the *siesta*, that is, a short sleep after the midday meal. During digestion blood is withdrawn from the brain in order to increase the supply of blood to the digestive organs. As the older physiologists put it, when a man is thinking, "the little devils" are in the brain; when he is digesting, the little devils are in the stomach; and it is obvious that the little devils cannot be in both places at the same time.

After a light meal, and this short *siesta*, the afternoon, whether its activities be mental or physical, can be faced with every prospect of enjoyment and freedom from worry. Worry is one of the great evils frequent among middle-aged people. It keeps them awake; it

prevents them from enjoying their food; and doctors have learnt that worry and anxiety are common causes of all kinds of ill-health, both mental and physical, from insanity to back-ache; from neurasthenia to skin rashes.

We are often told that we are becoming a country of old men and old women. It is true that our population is, on an average, getting older in years. But old people are getting much younger in ways and thoughts than they were; and with care along the lines suggested, both the age of man may be increased, and the period of senility postponed. The downward slope from the plateau may become much more gradual, and much longer.

Old Age

Imperceptibly middle age passes into old age, and it is convenient to use the word senescence for the normal changes and senility for the abnormal ones. Most of old age as we know it is senility, and a death from natural causes in civilized communities is quite rare. It has been calculated that the span of human life should be between ninety and a hundred years.

The determining factors in long life are partly due to heredity and partly to environment and habits. The late Sir Humphry Rolleston quotes the experience of Cardinal d'Armagnac in 1554, who found a man of eighty-one weeping in the street because his father (at a hundred and thirteen) had beaten him for not taking off his hat to his grandfather aged one hundred and forty-three.

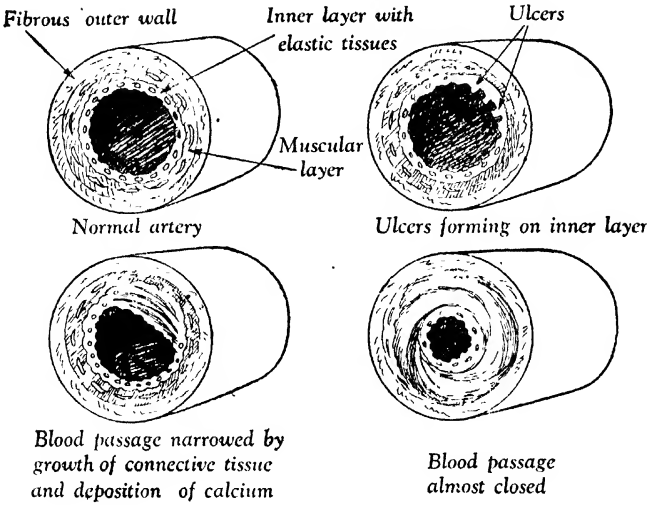
Good stock may ensure long life in spite of bad environment, such as town life and alcoholism, but an individual without a good family history may prolong his life by careful measures.

Hardening of Arteries

Various people have selected, quite arbitrarily, ages at which senescence may be said to start; the dates range from forty to seventy-five. Several authorities have pointed out that "a man is as old as his arteries," or "as old as he thinks he is"; so that it varies with every individual. For practical purposes sixty-five might be named, but many people of fifty-five are as old as others of seventy.

A great deal does depend on the state of the heart and arteries, because if they are not working well they fail to supply adequate nourishment to all the other tissues. The hardening process in the walls of the blood-vessels which is the outstanding feature in old age is believed to be due to stress, worry and lack of exercise. If this be so, it should be largely preventable by the careful cultivation of the quiet mind and suitably exercised body.

Actual death from senescence is probably due to failure of the nerve cells. These cells are all manufactured before birth and no new ones can be added. When their span of life is over, they cannot be replaced and, if they are in key positions in the body, then the body cannot



HOW THE ARTERIES HARDEN

A man is often said to be as old as his arteries. The hardening process which takes place in the artery walls is shown in these diagrams. Ulcers form on the inner layer, connective tissue grows, and calcium is deposited, until the passage is almost blocked and circulation of the blood impeded.

continue to live. Obviously, they may die earlier than they otherwise would if their blood supply fails them. Disease often leads to atrophy before the natural time and the cessation of active life on retirement may bring on old age prematurely.

Senescence is characterized by a general atrophy or wearing out of all parts of the body but they tend not to wear out at the same time. On the whole, the more active cells wear out faster than those which are only serving as supports or packing.

The fat stores diminish out of proportion to the rest of the tissues round them and so the skin loses its smooth rounded appearance and falls into folds. It becomes dry and glossy as a result of the atrophy of its own cells and those of the sweat glands; it is wrinkled because its elastic tissue has worn out; it is smooth because the hair follicles are disappearing.

These changes are especially seen on exposed parts like the back of the hands and the head. The skin becomes ivory coloured and cold, and does not bleed so much when cut, because the tiny vessels supplying it are undergoing atrophy. The lack of fat makes the veins stand out.

The local atrophy of the hair roots may cause baldness or scarcity of hair, and such hair as is left becomes grey or white.

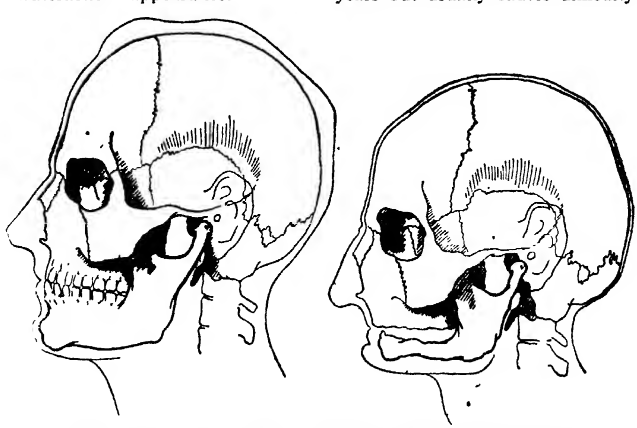
As a result of weakness of the muscles, the back becomes bent; the soft buffers between the bones of the spinal column atrophy early, so that the bones get closer together and the height is reduced, and sometimes the bones alter their shape, producing deformity. Calcination of the bones of the framework sets in, causing the bones to become chalky and brittle, so that they are easily broken, and mend with difficulty. Thus a fracture of any sort in old age is very serious.

Teeth have often been removed earlier, in civilized life, but if not, they tend to fall out in extreme old age, and the toothless jaw changes its shape, getting the characteristic "nutcracker" appearance.

The heart muscle shows less atrophy than any others, but degeneration of the elastic tissue and muscles in the blood vessels makes them inelastic and stiff. All muscular movement becomes slow and uncertain.

All the factories (or glands) of the body show some degree of atrophy, and the liver may be diminished by as much as half, both in size and weight. This means that digestion is more difficult and meals should be small and simple. The old do best on crisp dry food, satisfying their thirst between meals only.

Atrophic changes in eyes cause difficulty in focusing down to close objects. The long sight of old age is due to failure of the elasticity of the lens of the eye—a process which goes on slowly throughout many years but usually causes difficulty



JAWS OF AN OLD AND A YOUNG MAN CONTRASTED

In old age teeth tend to fall out, if they have not been removed earlier, and the toothless jaw assumes the characteristic "nutcracker" appearance.

between the ages of forty and fifty. It is easily corrected by wearing the right kind of spectacles.

Sometimes the lens fibres also become hard, and a patch obscures the sight, forming the condition known as senile cataract, which is put right by operation. The grey line round the margin of the coloured part of the eye is characteristic of old age but of no importance; and sometimes there are yellowish patches on the lids or the white of the eye which are harmless, if a little disfiguring.

Failure of Faculties

There are two kinds of deafness in old age: one is due to previous catarrh of the nose and the throat, and can be prevented by attending to the catarrh properly in earlier life; the other is due to atrophy of the nerves in the inner ear and can only be helped by a speaking tube —and by giving up smoking.

The degeneration in the nervous system cells produces failure of the higher faculties, such as memory, initiative, originality and humour. Concentration and attention are impaired, and mental fatigue occurs more readily; indeed, it has been said that old age is nothing but progressive fatigue.

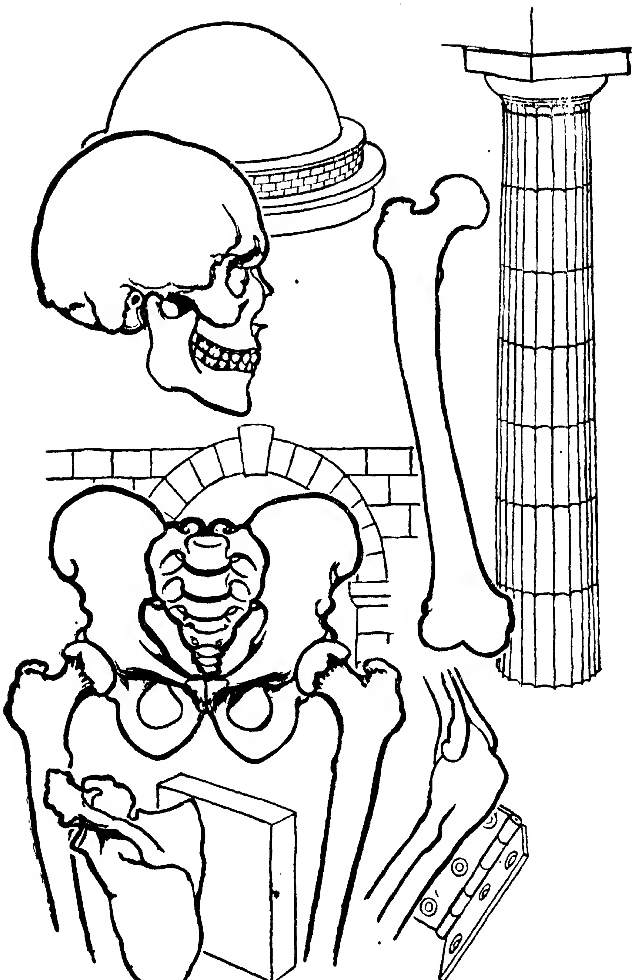
Senile decay has been defined as the period in which a man ceases to adjust himself to his environments. Some people, according to this standard, are old in their twenties; others never grow old. The best antidote for senile decay is an active interest in general affairs. It is possible, by planning suitable interests and activities, by strengthening the will through simple physical exercises, and by guarding against automatic stereotyped judgments, to maintain a lively interest up to a great age.

There are many examples of those who have achieved this. Titian was painting his finest pictures in his hundredth year. Goethe worked until he was over eighty and wrote some of his finest poems when he was over seventy-five. Darwin wrote *Descent of Man* when he was sixty-two. Carlyle's *Frederick the Great* appeared between his sixty-third and seventieth years. Gladstone was Prime Minister at eighty-two. Thomas Edison was actively at work at eighty.

Maintaining Interests

The old must practise hobbies, crafts or other activities which form a real contribution to the culture of their time. Sometimes these are interests which attracted in youth but were overlaid by the pressure of the life of materialistic maturity.

Above all, the old must not slip into the habit of living in the past and of seeing in everything new only things which they bring with them from past experiences. Keeping up to date intelligently is another term for accepting the new. A strong desire to live for a special purpose is a great help in postponing senility. It has been said that too often a man's last occupation is to shorten his existence and make it miserable.



THE BONES AS ARCHITECTURAL UNITS

Bones form the main supporting structure of the body and serve various functions. Here are some compared with the architectural forms they resemble: the skull with a dome; the thigh-bone with a column; the pelvic girdle with an arch; the elbow with a hinge; the shoulder-blade with a corner-stone.

CHAPTER THREE

STRUCTURE OF THE BODY

Framework of the body. Packing of connective tissue. Composition of bone and muscle. Muscular energy and its cause. Structure of skeleton. Spine and bones forming chest cavity. Shoulder girdle and elbow joint. How a muscle acts over joints. Hip girdle. Protective layer of fat. Composition of skin. Control of temperature by sweat glands and surface blood-vessels

ALTHOUGH the word skeleton is generally taken to mean bones, or possibly also the cartilage which is attached to the bones in places, the supporting structure of the body includes a great deal more, and many parts which are bony in man may be made of gristle or membrane in other animals, and vice versa.

All the structures of the body are most carefully "packed," as a precious piece of china may be packed in cotton wool and layers of paper for transmission through the post. This packing tissue varies, from almost invisible thin silky or fluffy material to stout membrane as strong as canvas. It is called connective tissue.

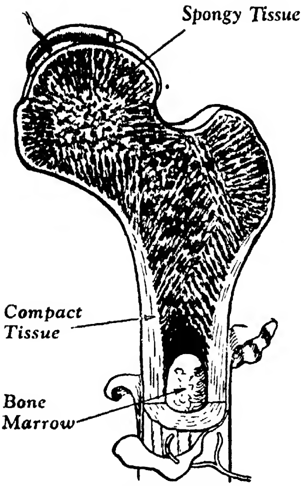
Every microscopic fibre of every muscle is enclosed within a sheath of connective tissue. These fibres are then joined into bundles, and each bundle is wrapped round, with a little loose packing between them to make them fit snugly.

Finally, the whole muscle is wrapped in what is called its muscle (or tendon) sheath and connective tissue is packed between adjacent muscles.

The same kind of packing is applied to the nerves, while every bone has its own sheath, which is called in this case the periosteum. Moreover, connective tissue supports the marrow inside the bone, and constitutes the ligaments and joints which bridge the gap from bone to bone. If every other tissue could be dissolved away, and only the connective tissue left standing, the result would be practically an outline model of the entire human frame.

The condition of the bony supporting structure of man varies very much with age. In the earliest stages there are no bones at all and the process of turning different kinds of connective tissue into bone goes on actively during childhood and to some extent throughout life. Because much of the young child's structure is membraneous or cartilaginous, that is, made of gristle, it can stand falls and bumps far better than the adult man.

Nearly all the bones are made to move upon one another and the adjacent parts of them are modified to form the joints, or moving parts.



SECTION OF BONE

This section of thigh-bone shows the composition of long bones, which consist of an outer hard shell (compact tissue), a marrow cavity in the centre, and a filling of spongy tissue, arranged in layers, at each end.

The bones, then, serve a number of functions: they give rigid support; by their joints they ensure flexibility; they also afford points of attachment to muscles.

Muscle tissue is a very specialized form of connective tissue. Next to the nervous tissue it is the most highly specialized in the body, and the most difficult to replace if there is any loss. It has the peculiar property of shortening, so that the two bones to which its ends are attached are drawn together.

Muscle may in rare instances be attached to something other than bone, but the general rule is that muscle rises from one bone at one end and is inserted into another bone at the other end.

Muscles usually mark the bones to which they are attached, so that they become rough and craggy where fibres arise. Where strong tendons are inserted into a small area of bone a big hump is often pulled up on the bone to supply good leverage. That is why bones have such curious shapes. No muscle is attached to the crown of the head, which is, therefore, smooth and even.

Sometimes a muscle consists of fleshy contracting fibres throughout its entire substance; it then constitutes what we eat as lean meat. But for mechanical reasons it is often an advantage to have a thick bunch of these fleshy fibres drawn together, near the bony attachment, into a strong cord, or tendon, which can be packed into a much smaller space than the corresponding muscle fibres, and which, though incapable of contracting, can exert the pull of the muscle and leverage.

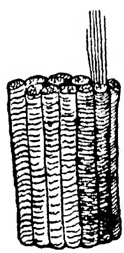
Achilles Tendon

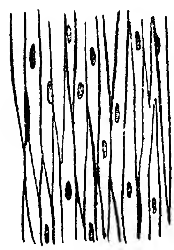
The largest tendon in the human body is the Achilles tendon at the back of the heel. It is so called because of the legend that the mother of the warrior Achilles dipped her baby in the river Styx to make him invulnerable; but she held him by the heel, and an arrow through this vulnerable part eventually caused his death.

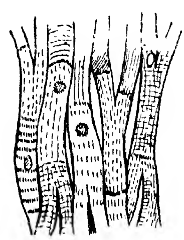
In other places it is convenient to attach the contracting fibres to a a broad stout sheet of membrane; these are called aponeuroses, and a good example is the insertion of the muscles of the abdomen. Instead of joining a bone in front, where there are no bones available, the fibres are inserted on both sides into the membrane which runs down the front of the abdomen, and has much the same effect as a corset or body belt.

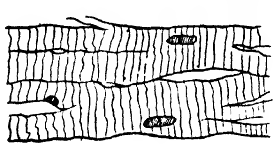
In this chapter the word muscle is used to mean voluntary muscle; the involuntary muscles found in the digestive tract and other internal organs do not obey the same laws and do not move the bony framework about. The voluntary muscles are so called because they are contracted and relaxed at will.

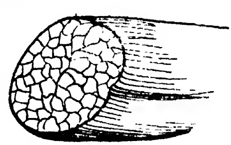
We cannot, however, say to a muscle: "You contract." The part of the conscious brain which governs the movements can picture changes of position, but not the individual muscles which bring it about. The brain can say: "Bend the elbow", and this order is then conveyed to the spinal cord, and there transferred to an effector neurone which knows which muscles to employ to effect the desired


Muscle Fibres


Involuntary Muscle Tissue


Cardiac Muscle Tissue


Striated (voluntary) Muscle Tissue


Section of Muscle

COMPOSITION OF MUSCLES

Muscle cells are drawn out into long fibres and bound together in bundles (upper left and lower right). Voluntary muscle tissue is ringed (striated), while involuntary muscle tissue is smooth. The heart, or cardiac, muscle tissue is between the two in appearance, with fibres connected by branches.

action. The general may say: "Take that strong point"; but it is junior officers who detail the actual platoon or company which does the job.

Of course, professional strong men and others who have studied muscle anatomy can sometimes order an individual muscle to contract, and stand out, without effecting any movement; but this is a trick learned in conscious life, and not a natural use of the brain cells which control movement.

Sometimes the voluntary muscles are called striped muscle because under the microscope, where they appear as long cylinders, they show tiny criss-cross lines which are not seen in the elongated spindles of involuntary or unstriped muscle.

Power of Muscles

The muscles are amazingly strong; a single muscle, taken out of the body of a frog and made to contract by an electrical stimulus, will lift a thousand times its own weight. In the body the muscles usually act at a great mechanical disadvantage, like running a car on high gear, sacrificing power to speed. Nevertheless, the muscles on the front of the arm, bending the elbow joint, which weigh about three-quarters of a pound, can in a single contraction raise their own weight one hundred feet. Working at a mechanical disadvantage of 10 : 1 they can hold up two hundred pounds.

Yet what are they made of? Jelly! Take away the fibrous supporting and packing tissue, and this surprisingly powerful delicate substance is found to have the consistency of a rather badly set jelly.

The fibres are about one two-hundred-and-fiftieth of an inch across and an inch to an inch and a half long. Each fibre has a single microscopic nerve fibre entering it and breaking up into an irregular pattern inside its sheath, and this vital contact between muscle and nerve is called the motor end plate.

Muscle Nerves

Between the fibres are scattered nuclei, showing the original derivation from ordinary mesoderm cells, and the ends of sensory or afferent nerves arranged in a twisted form which gives them the name of muscle spindles. These convey to the brain, though not often to consciousness, the condition of affairs within the muscle: its state of contraction, its position, and so on. The only common awareness we have of our muscles is stiffness, which may be due to swelling, or an imperfect economy in the chemical processes of contraction.

There are over five hundred muscles in the human body, and they constitute 45 per cent of the weight of most mammals. A muscle does not contract all at once, but in units of some hundred and fifty or two hundred fibres, which will all be co-ordinated by one nerve. The units are graded, and more and more are called upon in proportion to the effort demanded.

The speed of movement varies in different animals: the muscles in the leg of a tortoise take thirty seconds to contract, while those in the wing of an insect can contract three hundred times in one second. The quickest movement of man lasts about a tenth of a second, and even this speed requires considerable effort and training.

Speed is a compromise between the value of swift movement and the tendency of long things to break if they are moved fast. The greatest speeds are, therefore, found in small, light insects. Mammals are very breakable creatures, and it would be easy to snap a tendon or bone by allowing the muscles to move it about too fast.

In an isolated muscle about 40 per cent of the total energy used to provoke a contraction is converted into muscle-work, but in a living body even the best athlete gets only 30 to 35 per cent out of his muscles, and the average person no more than about 20 per cent.

Muscle Resistance

The remaining energy is taken up partly by overcoming the resistance of the muscle tissue. Its jelly is like treacle, sticky, and resentful of a change of shape; therefore a certain amount of effort and time has to be used to overcome this before the muscle will act. This explains why it takes more energy to perform a movement swiftly than slowly.

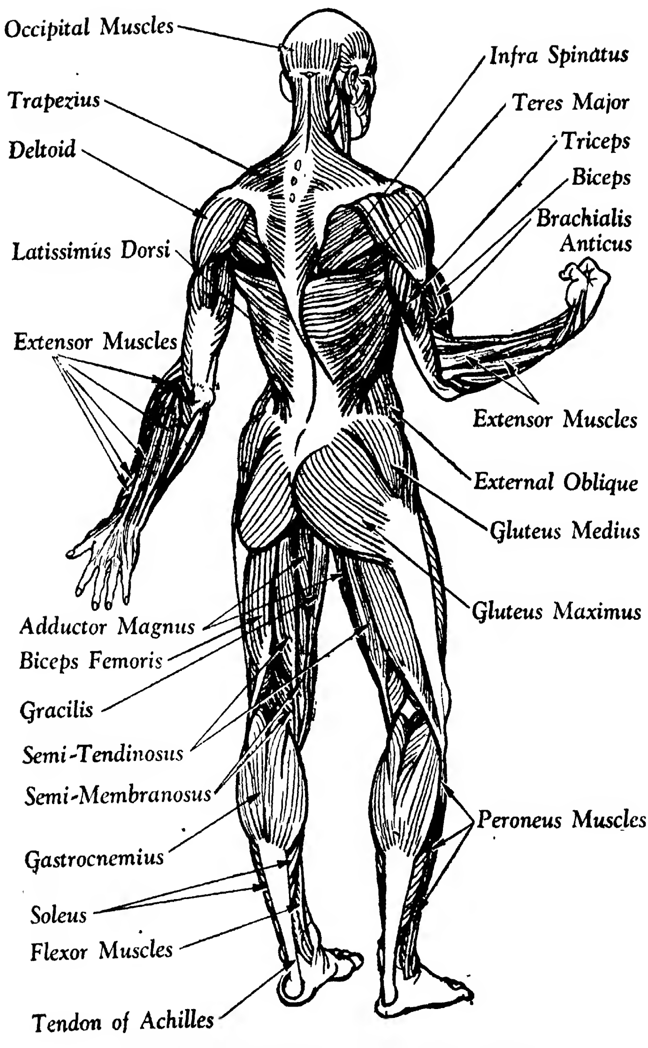
There is an optimum speed for each muscle: a speed that yields the greatest amount of work in a given time. The marching rate of the army is the result of investigating this optimum. The stickiness is, however, to some extent an individual factor, which is why some people can sprint more easily than others. A world-record holder for the sixty yards was found to have much less sticky muscles than his rivals.

As a result of contraction, fluid accumulates in muscles, and is not removed for some hours; even eight hours after activity a muscle may be found to be 20 per cent heavier than its normal weight. This accumulation of fluid may account for stiffness.

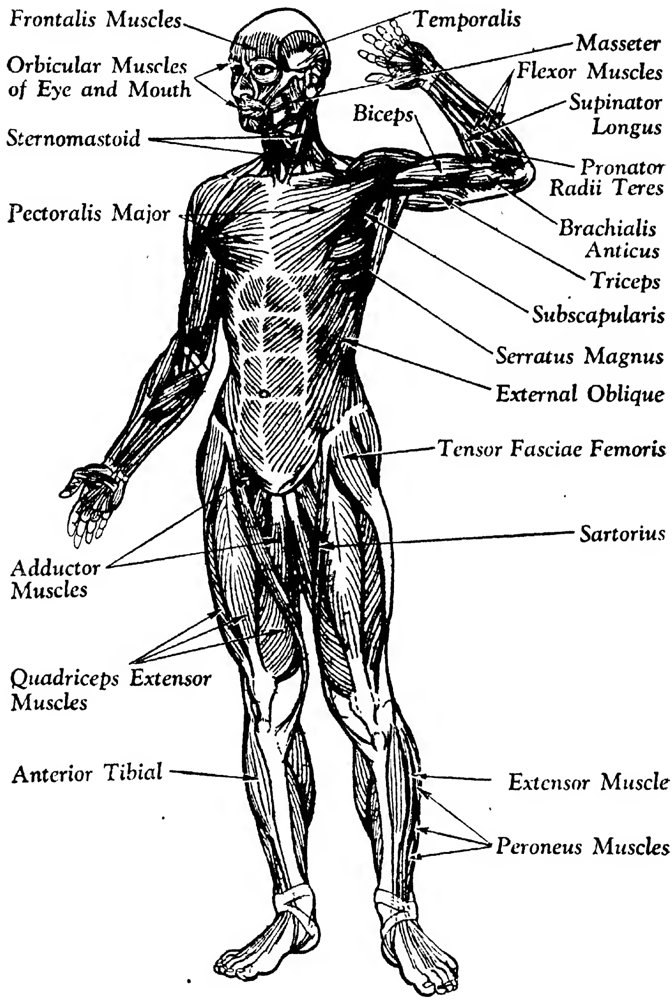
Oxygen Debt

There are several theories to explain why and how muscle fibres contract; it is a very complicated chemical and physical process, involving the alteration in composition of the muscle proteins. One certain thing is that a good supply of oxygen is necessary, and for this purpose the muscles are freely supplied with blood. Everyone knows how much the breathing is accelerated and deepened by muscular activity; this is to ensure adequate oxygen supply.

Indeed, so anxious is Nature that the muscles shall not be let down by the lungs that she has arranged for an oxygen overdraft in times of emergency. This is called the oxygen debt, and means that the oxygen used up in a period of intense muscular contraction can



SURFACE MUSCLES OF THE BODY (BACK)



SURFACE MUSCLES OF THE BODY (FRONT)

be repaid by the lungs after the activity has ceased; thus we go on panting long after the end of the race.

A second fact of which we are sure is that carbohydrate, particularly sugar, is the important fuel for the muscle furnaces. A third certainty is that as a result of prolonged action the muscle becomes acid, owing to the formation in it of lactic acid. A fresh resting muscle contains about 0·015 per cent of this acid: a muscle exhausted by fatigue as much as 1·16 per cent. Since the amount of glycogen (carbohydrate) is in inverse proportion, it seems reasonable to conclude that in contraction glycogen is changed into lactic acid.

Acid in Muscles

Lactic acid is the waste product of muscular contraction, and it is poured into the veins for excretion. If it cannot be removed as fast as it is formed, it brings on fatigue and an enforced rest period. Fatigue can be artificially induced in an isolated muscle by giving it lactic acid; and energy can be restored by washing out the acid.

The breakdown of glycogen into lactic acid can take place without oxygen, but where oxygen becomes essential is in the removal of the lactic acid, as the only way this acid can be removed from the body (except unimportant traces in the urine) is by turning it into water and carbon dioxide, the latter then being breathed out. This change requires oxygen.

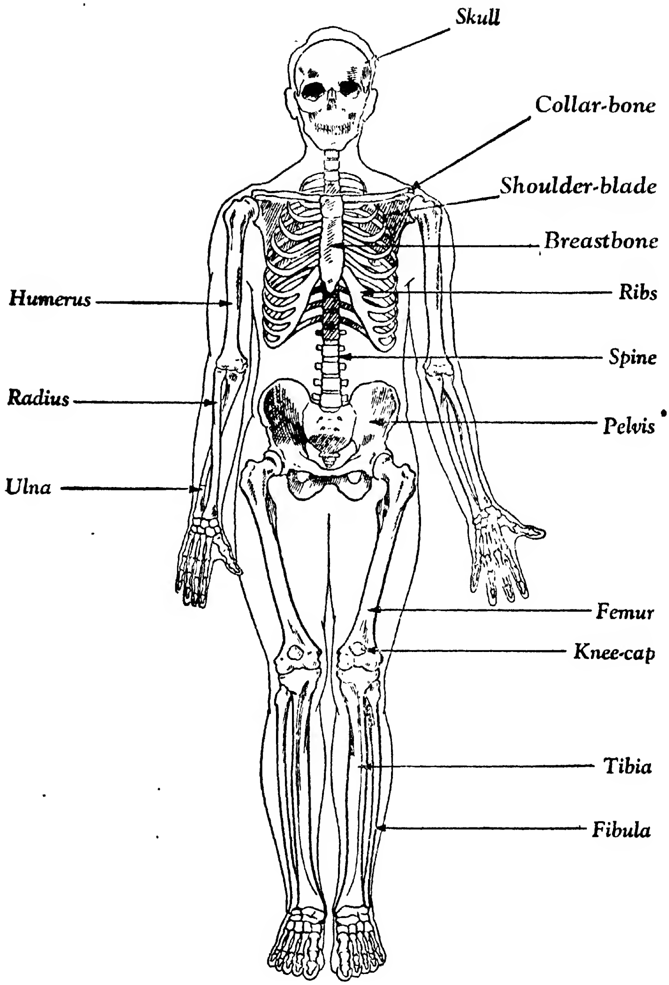
As well as the chemical change, the contracting muscle also undergoes a thermal change, that is, it gives off heat, and an electrical change, whereby an electrical current runs from the resting part of the muscle to the contracting part. But, given all these facts, exactly why these changes should cause a piece of jelly to shorten with such power remains a mystery.

As well as the vigorous activity resulting in active movement, muscle has a permanent condition of alertness called tone. Otherwise the body would simply collapse into a heap when it stood still or sat down on a chair. Tone means a condition of "having steam up in the muscle boilers," and ensures that they can begin to contract directly the stimulus reaches them. It is a reflex phenomenon, and does not cause any measurable fatigue.

Composition of Skeleton

Having dealt generally with the human framework, we can now proceed to examine it in detail. The skeleton consists of two parts, the axial skeleton, including the skull and backbone, ribs and breastbone; and the appendicular skeleton, that is, the limbs and limb girdles.

The backbone consists of thirty-three small bones piled up on one another like a stack of coins. They are of five kinds: seven cervical ones in the neck, twelve dorsal ones (to each of which two ribs are attached at the back) in the chest; five lumbar ones in the small of the



FRAMEWORK OF THE HUMAN BODY

The skeleton is made up of two parts: the axial skeleton (skull, spine, ribs and breastbone) and the appendicular skeleton (limbs and limb girdles).

back; five sacral, which are fused together to form one bone, the sacrum, and a number of little degenerate tail bones which form the coccyx. Each bone, or vertebra, consists of a solid oval or heart-shaped body and an arch formed over the spinal cord.

The reason for having a number of small bones is the flexibility of movement which is thus made possible, but, of course, this also carries a risk of separation of the vertebrae, which are therefore held together by powerful bands of tough connective tissues (ligaments) which run all the way up and down the column, in front of the bodies, behind the bodies, and between the arches. The column is also supported by bands of muscle, which are massed especially behind the arches of the vertebrae.

Spine and Ribs

The ligaments up and down the front of the spine are tough and unyielding and that is why it is more difficult to bend backward than forward. The ligaments between the arches contain elastic tissue which enables us to increase the space between the arches and thus to bend forward without doing any damage to the spine.

The whole series is so arranged as to form four curves. When looked at in profile: in the neck it slightly curves forward, in the back it curves outward, in the loin it curves forward again, and then the sacrum and coccyx sweep out in a convex backward curve. This curve is provided for in the shape of the vertebrae.

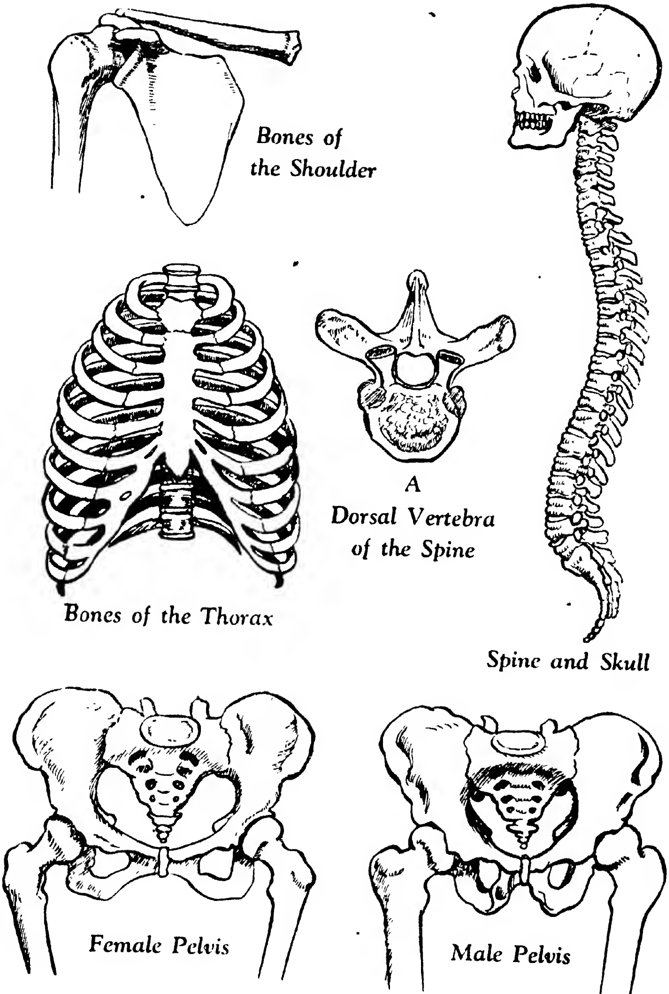
The ribs are twenty-four long slender curved bones joining the spine at the back and curving round to meet with the breastbone or each other in front. The first seven are called true ribs and join the breastbone by bars of cartilage. The lower five false ribs do not connect with the breastbone directly, but three of them join to a common bar of gristle which reaches the breastbone, while the last two are not attached in front at all and are called floating ribs.

Chest Cavity

The backbone and breastbone and ribs together form a conical cage, called the thorax, which is narrow at the top with a broad opening at the bottom; it houses and protects the lungs and heart. The spaces between the ribs are filled in by two layers of muscle and packing tissue. The space at the bottom is filled in by the diaphragm muscle, which separates the chest cavity from the body cavity.

Some animals have more than twelve ribs on each side. For instance crocodiles have some in the neck and birds have some nearer the tail. The upper shell of tortoises is made up of several expanded ribs joined together.

Very occasionally man develops what is called a cervical rib. That is to say, a bone appears in the arch extending from the lowest neck vertebra behind and curves round toward the top of the breastbone.



STRUCTURAL BONES OF THE BODY

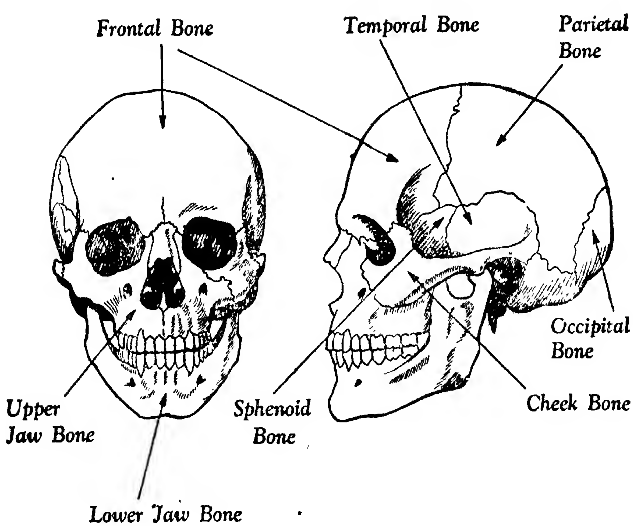
The main structural bones are spine and skull, thorax, shoulder girdle and hip, or pelvic, girdle. The female pelvis is wider than that of the male, with a larger space in the centre, to allow for the passage of the child at birth.

This may press on the nerves and cause pain, and then a surgeon has to remove it.

The skull of man consists of three parts: the brain case; the bony supporting structure of the face; and the lower jaw. Since man is characterized by a large brain, he naturally has an exceptionally large brain case relative to the skeleton of the face. Man's face also became reduced by the development of the hands in the process of evolution (see page 140). It is possible that this reduction is still going on and that man of the future will have far smaller jaws and an even larger brain case than he has now.

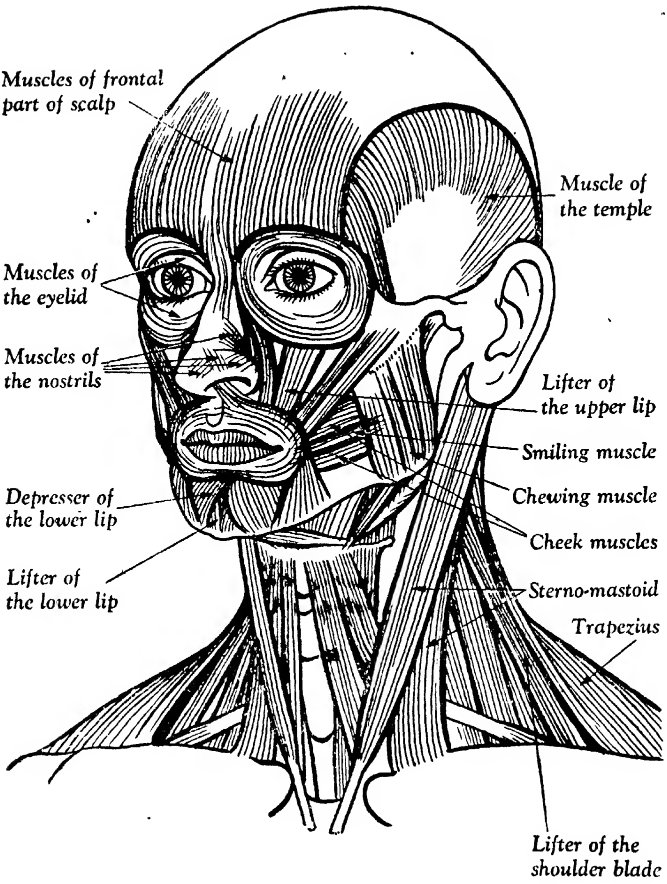
The brain case consists of six smooth curved bones which reach up and meet in zigzag lines known as sutures. There is no movement between these bones, and therefore the join is just an intricate meeting of the bone plates with a little connective tissue between. The whole of the front of the brain case and part of the roof of the eye sockets, right back to two to three inches behind the hair line, is formed by one bone, the frontal.

This meets two bones, which



BONES OF THE SKULL

The brain case of the skull consists of six smooth curved bones which meet in zigzag lines. These join the bones of the face, while the separate lower jaw bone is joined to the temporal bone of the brain case by a hinged joint, which makes possible the powerful movement of the lower jaw.



MUSCLES OF THE HEAD AND FACE

The muscles of the face and head are very important. They give expression to the face and enable us to show our feelings and emotions. For instance, the muscles of the forehead are used when we frown; the muscles round the eye move and close the eye, and also screw it up; the muscles of the nostril enable us to sniff and sneer; the muscles encircling the mouth lift and pull down the lips, are used when we smile, and register many other emotions.

join each other in the middle line and form most of the side and the top of the head—the parietals. Right at the back is another single bone, the occipital. Joining each parietal, underneath the ear and above and in front of it, are a pair of bones called temporals.

At the base of the skull, completing the floor of the brain case and the back of the face skeleton, is a very complicated bone shaped roughly like a butterfly with long narrow wings — the sphenoid. Attached to this in the front is the bone of the upper jaw, the maxilla, which bears the upper teeth, and which joins a short nasal bone at the root of the nose and the malar or cheek bone at the side.

Bones of Face

There is practically no movement in any of these bones; they are all joined by sutures. To make them lighter, most of them are hollowed out, and the cavities so formed are lined with soft pink spongy lining, as the inside of the nose, with which most of them connect. They are called sinuses, and infection from the nose may get into them and be very difficult to remove.

Besides these large bones, there are also two complicated little hollow bones at the back of the nose called the ethmoids; the palate bones, wedged in between the maxilla and sphenoid; the vomer, a single bone at the back of the nasal septum, and two lachrymals, forming part of the eye socket.

The only separate bone of the skull is the mandible or lower jaw, which is a curved or right-angled band of bone bearing the lower teeth and making a hinged joint with the temporal bone of the skull.

The skull thus encloses a number of cavities. The first is the brain case, which is completely shut in save for small holes by which the nerves and blood-vessels leave and enter, and the large hole at the base for the spinal cord; the second is the eye socket, a cavity open in front but having only a narrow hole at the back for the nerves and vessels; and the third is the nasal cavity, divided into two by the vomer at the back and the cartilaginous septum in front.

Finally, there are the sinuses: two in the upper and lower jaws, one in the sphenoid, two in the frontal (making the bosses, or protuberances, over the eyes), two in the mastoid (or lump of bone behind the ear), and a number of smaller ones in the ethmoid.

Upper Limb Girdle

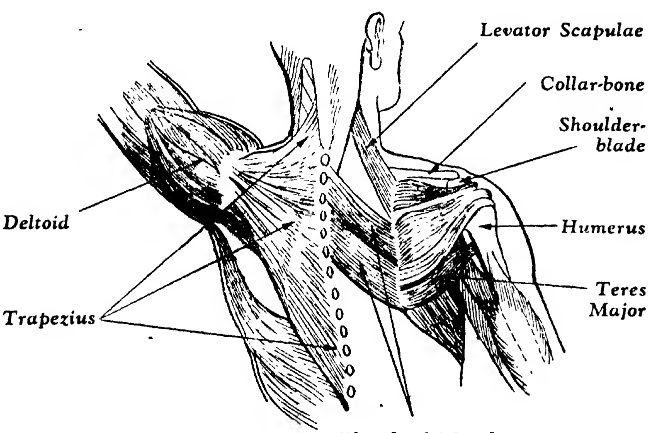
The upper limb, or pectoral, girdle consists of the shoulder blade (scapula) and collar-bone (clavicle). The collar-bone joins the breastbone (sternum) at a small, tightly-held movable joint, but otherwise the shoulder girdle is fastened to the body only by muscles: the great muscles, such as latissimus dorsi, which pass from the spine and ribs to the girdle itself and the upper part of the arm bone. This ensures flexibility of movement, and in this girdle stability is sacrificed to

flexibility, while in the hip girdle the reverse applies.

The girdle is also fastened to the skull by the great sternomastoid muscle, which runs from the breast-bone and collar-bone up to the back of the skull and the mastoid process behind the ear. This muscle, acting with its fellow of the opposite side, bends the head forward, and its strength is shown by those acrobats who hang by their chins from a trapeze, sometimes supporting the weights of one or two others.

The scapula is a flat triangular blade of bone offering a wide surface of attachment for muscles. Some of these, such as the great trapezius muscle, which tilts the blade, come to it from the arches of the vertebrae, others from the ribs; some go from it to the top of the arm bone. Rising from its back is a spine or smaller triangular blade set at right angles to the main one, and this increases the area of muscle attachment. It ends in two curved peaks, one of which (acromion process) unites with the collar-bone at another small and tightly held joint, while the other (coracoid process) overhangs and helps to protect the shoulder-joint.

The collar-bone is a slender bone lying just under the skin. The great chest muscle, pectoralis major, rises from the front of the ribs and from the collar-bone, and is



SHOULDER GIRDLE AND ITS MUSCLES

Man's shoulder girdle allows for the fullest possible movement of the arm. The outward movement is limited by the meeting of the arm bone and the overhanging process of the shoulder-blade. The continued upward movement is produced by the blade muscles in conjunction with the deltoid muscle.

inserted by a stout tendon into the top of the arm bone, giving most of the strength of the hug.

The deltoid muscle, which forms the rounded point of the shoulder, rises from the outer half of the collar-bone and the spine of the scapula, and its fibres converge to be inserted on the outside of the top of the arm bone; this muscle pulls the arm bone out at a right angle to the body.

When this point is reached the shoulder joint can allow no more movement and the further upward stretch of the arm is produced by the muscles joining the shoulder-blade to the back. They rotate the blade, and the deltoid muscles see that the arm goes with it, so that the arm is swung up.

Collar-bone in Man

Animals which move their fore-limbs only forward and backward, as a horse does, do not have collar-bones—the bone seems to be necessary to brace the arm away from the breastbone, so that it can move round freely. It appears in its most primitive form as a sliver of bone in the midst of muscles, with no joints, in animals, like cats, which can wash their faces. Man, with his freely moving arm, has one of the largest clavicles known.

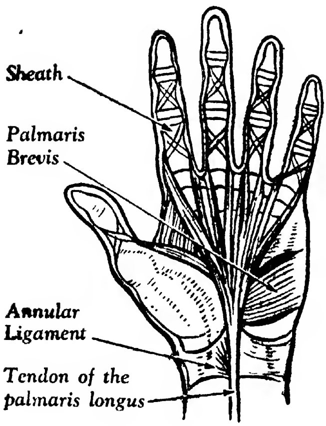
Man's shoulder girdle follows a primitive pattern. It is the swift-running animals which have specialized away from the primitive, losing their collar-bones and lessening the movements of their fore-limbs. They have done this in order to ensure fleetness of foot against flesh-eating enemies. Man could afford to be a slow two-legged mover when he came down from his tree with his big brain, much of which he owed in turn to the freedom of his forelimbs and consequent development of the sensitive and flexible hand.

Arm Bones and Joints

Both the collar-bone and arm bone (humerus) are typical long bones: that is to say, they are long and slender, have two expanded ends, and a central canal down the middle filled with bone marrow. The expanded ends are to provide joint surface and muscle attachment.

The upper end of the humerus has two humps, called tuberosities, for the attachment of muscles, and a nearly hemispherical smooth head for the shoulder joint. This head joins with an almost flat pear-shaped area on the shoulder-blade—a very poor socket for the ball of the head. It is a little deepened by a rim of cartilage, and it is protected by the overhanging process of the blade bone, by a tough membraneous sleeve running from bone to bone, and by the muscles.

Nevertheless, the shoulder joint is a precarious one, with stability far behind movability. For this reason it is one of the commonest joints to get put out, or dislocated. It is the most freely moving joint in the body and enables the arm to be moved in almost any direction. The locking position of this



TENDONS OF THE HAND

The tendons and ligaments of the hand help to give it the flexibility so highly developed in man, enabling him to perform tasks requiring delicate and precise movements.

joint is brought about by the meeting of the arm bone and the overhanging process of the shoulder-blade.

Half-way down the humerus there is a change-over from insertion of muscles coming from above and acting on the shoulder joint to muscles arising from the arm bone and going down to the forearm to move the elbow joint.

There are two important muscles which bend the elbow: brachialis anticus, rising from the lower half of the humerus; and biceps, which, as its name implies, arises by two heads from the shoulder-blade, one above the shoulder joint, and the other from the coracoid process. This muscle thus acts on both the shoulder and the elbow joints.

There is a big three-headed muscle (triceps) arising from the lower half of the back of the arm bone and reaching to the point of the elbow, to bend the elbow joint back.

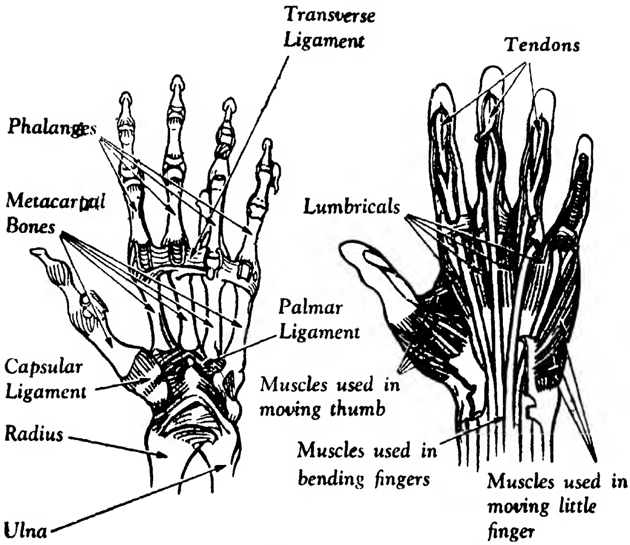
The elbow joint is a perfect hinge joint: the bones are so shaped as to fit precisely into one another and allow no side-to-side movement.

Muscles of Lower Arm

At the lower end of the humerus arise two big groups of muscles which pass over several joints: the elbow and wrist, and one, two or three of the finger joints. The ones rising from the lump (or condyle) on the thumb side of the humerus are called extensors and run down the back of the forearm to bend the joints back: the one rising from the condyle on the little finger side are called flexors, and run down the front of the forearm to bend up the elbow, wrist and finger joints.

Both sets give place to tendons about half-way down the forearm, and these tendons are most carefully packed around the wrist in slippery canals through which they can glide with the minimum of friction.

The two bones of the forearm are called radius (on the thumb side) and ulna (on the little finger side). More muscles arise from them, back and front, to join the extensor and flexor group respectively. A very important movement is that of rotation of the lower end



BONES AND MUSCLES OF THE HAND

Bones and principal ligaments of the hand (left), and (right) muscles and tendons used in moving the thumb and fingers. The muscles called lumbricals shown above (right) assist in the bending and stretching of the fingers.

of the radius round that of the ulna, so that the hand can be turned palm up (supination) or palm down (pronation).

The wrist joint is another hinge joint, but not quite so perfect as the elbow joint, for it allows a little side-to-side movement. The wrist is composed of eight small bones in two rows, each of them having movable joints between itself and those which touch it.

From the far side project the five metacarpal bones, small long bones; the four finger ones have hinge joints, but the joint between the wrist and the thumb allows the thumb to swing round and meet the palm or tip of the other fingers.

This power of opposition of the thumb is an extremely important one in evolution, and had much to do with the superiority of the creatures who have it. The apes have it, and so have some of the monkeys, but most monkeys seem to have preferred a prehensile tail.

Each finger has three rather squat long bones, united by hinge joints, and the thumb has two; these are called phalanges, and the last one, short and squat, bears the nail at the end. Some short muscles arise in the palm of the hand and

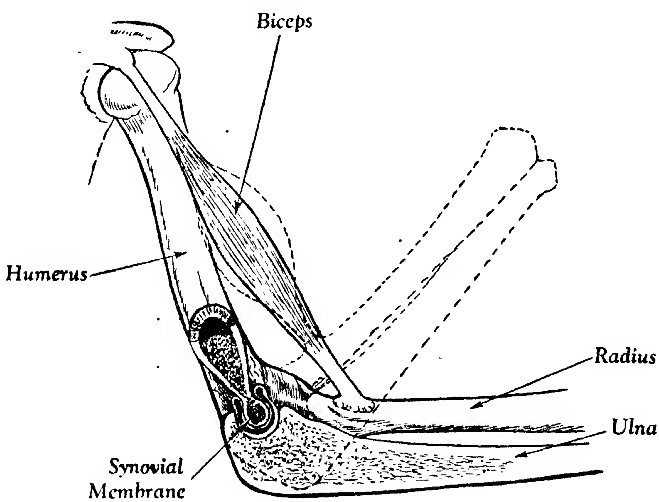
between the metacarpals, to be inserted into the sides of the phalanges; these are responsible for the side-to-side movement of the fingers—a very weak movement compared with the power exerted by the long flexor and extensor muscles of the forearm.

The arm offers a good opportunity to study the ways in which a muscle may act over joints.

In the first place, it may simply contract, to draw two bones together and perform the movement desired by the conscious brain cells. "Bend my elbow," "Let brachialis contract," are the two stages of such a movement, and the brachialis is then known as a prime mover.

With no opposition the other hand would have to be used to prevent the moving forearm from snapping shut on the arm like a spring door.

The forearm moves slowly and controlledly on the arm, with just the required strength for the action, because whenever a prime mover contracts, the muscle which performs the exactly opposite movement relaxes steadily. Thus, when the flexor of the elbow is prime mover its opposite number, the extensor, is just as much in action, only stretching instead of shortening.



HOW THE ELBOW BENDS

The elbow is a perfect hinge joint, which moves smoothly in its socket as the bones of the forearm are lifted. The dotted lines show how these bones are lifted by the shortening of the biceps muscle, causing the elbow to bend.

In this case the extensor is called the opponent.

That is enough for simple muscles passing only over one joint, but when they pass over several joints there has to be some arrangement to prevent all the joints being moved when only one or two are wanted. The long flexors of the forearm can be used to bend the elbow, the wrist and the first phalanx. Supposing we wish to bend the fingers on the hand, while keeping the arm and wrist stretched full out, then some muscles must concern themselves with preventing the flexion of the elbow and wrist. Such muscles are called synergics.

Finally, a muscle may be called upon merely to hold two bones steadily in a given position while some other movement takes place outside the joint which that particular muscle governs. Then it is called a fixator. For example, when the arm is at right angles to the body, and is to be swung up beside the head, the deltoid holds the humerus at full extension on the shoulder blade while the blade itself is rotated to complete the required arm movement.

Hip Girdle

In the hip, or pelvic, girdle, stability comes first. Man's posture as a kind of giant top, perched on the relatively narrow base of his two feet, is a constant insult to gravity and the laws of balance. Only by the most careful mechanisms is he kept stable in this unnatural position. There cannot be free movement of the leg as there is of the arm, or there would be too many dislocations in the act of running and walking.

Therefore the hip girdle is made of two large, solid plates of bone, and the hip joint is a perfect ball and socket, very firmly held in place by stout fibrous bands, as well as by large powerful muscles.

In childhood the pelvic girdle consists of three bones on each side, but in the adult they are all firmly fused into one on each side, and that one is firmly joined to its fellow in front and to the base of the spine, the sacrum, at the back by almost immovable joints.

Hip Bones and Joints

The expanded plate of bone which forms the prominence of the hip is called the ilium, and this is the part which has a joint with the sacrum, this joint being capable of a little sliding movement, but no more. Below, and in front, the ilium joins two bones, the pubes and ischium, which make an arch together round a hole which is filled in by muscle.

The two pubic bones join in another joint which can slide a little, and which is forced open to the full extent during childbirth. The ischial bones do not meet each other, but splay out and form the rounded prominences upon which we sit.

From the ilium and adjacent spine arise the great gluteal muscles of the buttock, which are inserted into the upper end of the thigh-

KNEE. JOINT

Three bones meet at the knee joint: the tibia of the lower leg, the femur, or thigh-bone, and the patella, or knee-cap, which lies in the tendon. These are joined together by very powerful tendons and ligaments.

bone (femur) and give it its powerful thrust backward on the spine, as in going upstairs. From the front of the ilium rises a big muscle which is largely responsible for flexing the thigh on the body. It is helped by some of the front thigh muscles which, like the biceps, rise just above the higher joint and work over two joints.

As a ball and socket joint, the hip allows movement to a limited extent in all directions, so that the thigh can be moved forward (flexion), backward (extension), inward (adduction) and outward (abduction), and also rotated inward and outward. All the muscles governing these movements arise on the pelvic girdle and are inserted into the upper half of the femur, except a long adductor which reaches right down the bone to just above its lower end.

Knee Joint

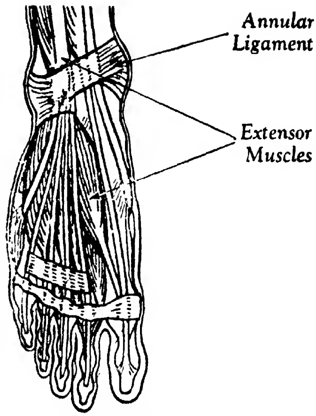
From the whole of the front and sides of the long smooth thigh-bone arises a mass of muscle with four main divisions, called, therefore, the quadriceps extensor; this extends the knee joint, giving the kick. The flexors, which bend the knee, and also act on the ankle, arise from rough protuberances at the lower end of the thigh-bone and form the bulge of the calf, acting on both knee and ankle joint.

The quadriceps ends in an aponeurosis and then a tendon, which is attached to the front of the top of the shin-bone. In the substance of this aponeurosis is a small thick flat bone called the knee-cap (patella). It is not known quite why it is useful there, but tendons often develop such small bones in their substance; the knee-cap is the largest and most constant of these bones, which are called sesamoid bones.

The two bones of the leg are closely tied together and do not have the power of moving on each other, as the forearm bones do

when the hand is twisted round. The bone forming the prominence of the shin is the larger, and is called the tibia; the other is very thin and is called the fibula. As in the forearm, flexor and extensor groups of muscles rise from the front and back of these bones and run to the toes.

Like the wrist, the ankle consists of a number of small bones (seven), all separated by movable joints, and there are metatarsal bones and phalanges. But in every respect these are more firmly welded and less capable of moving about, so as to give a firm support. The two largest of the ankle bones are called the astragalus and the os calcis respectively. The former takes the weight from the shin-bone and transmits it to the others, forming the keystone of the arch of the foot, while the latter is the principal supporter, and forms the prominence of the heel.



MUSCLES OF FOOT

The foot is a less flexible organ than the hand, since its function is to give support and stability. The tendons and muscles are therefore encircled by strong bands of ligament at the ankles and at the base of the toes.

Mechanics of the Body

The mechanics of the human body are extremely complicated, and include the two factors of movement and posture (or remaining in the chosen position against adverse influences such as gravity). A third activity is a combination of the two, since some postures have to be maintained during movement.

No machine yet invented comes anywhere near the intricacy and effectiveness of the human body. There are four hundred joints and over five hundred muscles working on these joints and—unlike a machine—the body can adapt itself to new circumstances around it and within it as required. Still further unlike a machine, and to a degree unique among animals, the movements of the body are used as a means of expression: indeed, a man's character can often be shrewdly judged by his gait and bearing.

This complicated structure of bones, muscles and joints, in addition to its packing of connective tissue, has a protective covering of specialized connective tissue cells. These cells, called fat cells, are swollen out of all recognition by huge drops of oil which distend their cell-membranes. This oil, or

fat, is fluid at body temperature, but solidifies soon after death; hence we think of the fat in meat as a white solid.

Fat tissue is useful both as packing and as a larder. It absorbs shocks very well, and the fat person is less likely to break his bones when he falls down than the thin person. It also breaks shocks between muscles and organs, and is found all over the body.

The chief depots, however, are just under the skin, around the kidneys (suet) and in a fold of thin tissue which hangs like an apron over the abdominal viscera, under the skin and muscles of the belly. This apron of fat is called the omentum, after the napkins which polite guests in classical times used to take with them to banquets in order that they might bring away delicacies and titbits from the feast.

Fat as a Fuel

Fat is the steady fuel of the body; for great, and especially sudden, feats of energy, carbohydrate is better and, indeed, according to one theory all fat has first to be changed to carbohydrate before it is burned in the body furnaces. Fat certainly constitutes a valuable fuel substance for keeping the fires going. On the fat stores a man can live for a great number of days without food.

Another fatty substance, though more a wax than a fat, is used to keep the skin supple and the hair glossy. This is called sebum, and is formed by pear-shaped glands which open into the hair follicles. It is better than fat as a protective salve, because it can take up as much as 100 per cent of water, and is not attractive to bacteria which might live in it, and perhaps turn it rancid as they do butter.

Salt Fluid of Body Cells

The human body still contrives to live under the sea! Life was first formed in the depths of the ocean, and then, much later, life came out of the ocean and began to inhabit dry land. But by that time all the life-processes had been developed in adaptation to a surrounding of salty fluid, and either they could not change, or for some reason they did not want to. So they contrived to bring their old environment with them, and the composition of this, called in man the internal environment, is most carefully and delicately maintained constant.

Here is a comparison between the elements in sea-water, diluted one in three, and those in the body fluids which bathe all the cells of a man's body:

	Human	*Sea-water*
Sodium	0·302	0·357
Calcium	0·009	0·009
Potassium	0·020	0·012
Magnesium	0·002	0·045
Chlorine	0·389	0·644

Why dilute the sea-water for this comparison? The answer is that many ages have rolled by since life came out of the sea, and during all those ages the processes of evaporation have been going on. Rain

comes down from the clouds, dissolving the minerals out of the earth as it runs to the sea along many river beds, and it enters the sea full of minerals. When it is drawn up again by the sun, in evaporation, to make more rain, the dissolved minerals are left behind.

Thus, the sea is very, very slowly getting more salty, and the truth seems to be that it is now three times as concentrated as it was when life left it.

If a solid body on earth is going to walk around in a private bath of sea-water, obviously it must have a waterproof envelope to contain its little ocean. This waterproof envelope is the skin, and it completely surrounds the whole of the tissues of the body.

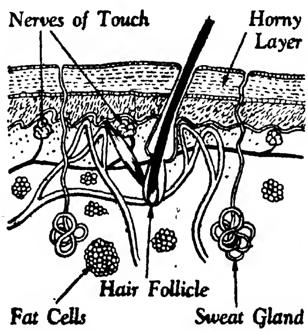
It serves a number of important functions as well as being an envelope: it protects the tissues inside it; it excretes some of the body's waste; it regulates temperature; it stores fat, water and salt; and, finally, it is an important organ of sensation and touch.

Outer Skin Layer

It is protective because the outside cells, those in contact with the environment, are dead. This part is called the epidermis, while the living part of the skin is called the dermis. The skin cells are constantly dying on the surface, and being cast off. Neither nerves nor blood-vessels penetrate this dead layer, and so it can be cut without loss of blood or pain, and can be rubbed off without damage to any essential structure.

The thickness of this dead protective layer varies very much; on the lips there is hardly any of it; on the heel it is at its thickest, where the contact with the ground is most likely to do damage. In danger spots like the sole of the foot it often develops a horny substance, which gives added protection, and in other animals may be developed into an external skeleton. Nails are a specialized and permanent part of this horny layer. Other parts become horny when exposed to special stress: for example, the calluses on the hands of the navvy.

The skin excretes some waste products through the sebum, already mentioned, and it is this oily or waxy coating which renders



SECTION THROUGH SKIN

The outer layer consists of dead cells, which form a horny layer protecting the live skin beneath. Below the living skin cells are the sweat glands, fat cells, blood-vessels, hair follicles and the nerves of touch.

it impervious to moisture. No substance dissolved in water will get through it into the body, and if the physician wants to introduce a medicament by this route he has to make it up in a greasy ointment. Even then it needs a good deal of hard rubbing to force it through the skin, and is most successfully applied where the epidermis is thin, for example, on the abdomen.

Manufacture of Sweat

Sweat is, of course, a greater source of excretion than the sebum. It is manufactured by vast numbers of small glands, looking like coiled tubes, which are found in varying numbers all over the body. There are far more of them in the forehead and palm and sole than on the back of the arm, for instance, which is why sweat pours from the forehead before the arm becomes noticeably moist.

These sweat glands are working all the time, whether the individual appears to be perspiring or not. The amount of moisture they pour on to the skin surface is, in non-perspiring moments, evaporated at once by the drier, colder air around, and is not noticed. Moisture is observed in the arm-pits and groin, not because there is a great secretion of sweat there, but because the air does not so easily get to these parts to evaporate it.

When moisture is removed from a surface by evaporation, some energy is required to turn the liquid into vapour, and this energy is obtained by using heat. Hence, to boil a saucepan dry it is necessary to apply heat to it. Hence, also, to evaporate sweat from a skin surface heat must be supplied, and is obtained from the body. Therefore, when sweat is evaporated, heat is lost.

It is in this way that sweat plays such an important part in the regulation of temperature. Water evaporates relatively slowly, and therefore we are not normally conscious of any sensation of cold when sweat is being removed.

If, however, it is removed faster than usual, because a wind is blowing, then we feel the sensation of chill on the skin. Thus an electric fan is refreshing on a hot day. If a drop of some substance, such as ether, which evaporates very quickly, is put on the skin, the cold feeling is obvious.

By means of nervous reflexes, the skin is informed when the temperature of the body rises above normal limits. It then increases the manufacture of sweat, which is poured on to the surface and evaporated, and thus the tendency to raised temperature is counteracted.

Blood-vessels of the Skin

Another way in which the skin helps to maintain temperature is by the opening or closing of sluice gates in the small blood-vessels which supply the dermis. If they are open, and much warm blood is flowing close to the surface, then heat will be lost through this closeness of warm blood to cold air, by the processes known as radiation

and conduction. Thus, when the body temperature tends to run too high, the exposed parts of the skin become flushed. When the body temperature tends to run too low, the blood-vessels are squeezed empty, and the skin looks pale.

This explains why it is dangerous to have a nip of alcohol to "keep out the cold"; alcohol artificially flushes the skin, giving a sensation of warmth, just when the wise skin, out in the cold, would shut all the small blood-vessels to preserve the heat in the centre of the body where the cold air cannot get at it.

Heat Retention by Fat Layer

A third way in which the skin—if the term be taken to include the tissue just beneath it—regulates temperature is by the fat layer; this acts like a fur coat, keeping the heat in. Fat people change temperature much more slowly, in response to environmental changes than do thin people, because the fat is like an insulating layer. Thus, in a way, fat people suffer from both cold and heat—they are slow to become cold, but once chilled have great difficulty in warming up again.

All these changes are controlled by centres in the brain, and instructions are sent to the skin vessels and glands by nerves belonging to the autonomic nervous system (see page 146).

Close to the thermostat, or temperature-regulating, centre are shivering and panting centres. Shivering is a vigorous muscular contraction, which promotes heat; panting is an attempt to get rid of more heat through the lungs, and is especially an activity of fur-coated animals, which cannot sweat and, therefore, have to increase heat loss through the lungs and by evaporation from the tongue.

Cause of Goose-flesh

These animals have, however, the advantage in heat-preservation that they can lift their hair (or feathers) so as to enclose a thick layer of air, which is kept still, close to the body, and quickly raised to body temperature. This function is performed for man by woollen garments. Feebly, his skin tries to do it still by raising the few little hairs it has left in the condition known as goose-flesh.

A very delicate balance is constantly being maintained in the body between the production of heat through all its manifold activities—glands and muscles especially—and the heat loss, which is mainly through the skin, though the skin is helped in the task by the small but steady loss of heat involved in breathing out hot breath and breathing in cold; and by the intermittent, very slight loss of heat with the excreta.

This preservation of a steady internal temperature, regardless of the heat of the outer world, is the achievement of the mammals, and did much to free them for further advancement in evolution.

In man the temperature maintained is about 98·4 degrees Fahrenheit, with a shift of about

a degree during the twenty-four hours. The temperature is highest between 5 p.m. and 8 p.m. because of the effect of the day's muscular activities; it is lowest in the small hours—about 4 a.m.—and that is the time when workers new to night duty experience the most overpowering desire for sleep.

Strenuous exercise may cause a rise of three or four degrees for a short time. Babies have not got their temperature-regulating mechanism fully established in their early months, and that is why they have to be wrapped up, and cannot be trusted to keep themselves warm enough. The temperature of the hottest room in a Turkish bath is not far off boiling-point, but because it is very dry, people can stand it, and sweat vigorously. A certain coal miner is reported to have produced nearly two gallons of sweat in six hours.

Salt Loss in Sweating

The pouring out of sweat carries with it small quantities of protein waste product, a little carbon dioxide waste product, and a good deal of salt. People who sweat much become thirsty from the loss of water—another important factor that has to be kept constant in the internal environment—and so they naturally drink to replace it. If they drink plain water, however, trouble may follow because they flood the internal environment with a too-dilute solution of salt. Sweat is salt water, and sweating loss must be replaced by salt water.

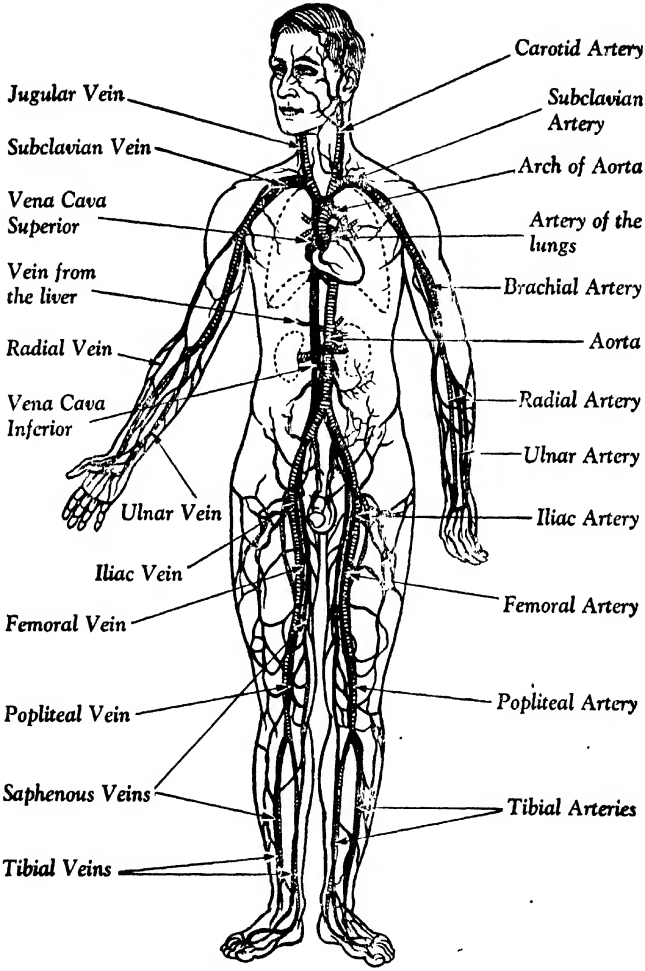
It is because salt is lost with the sweat that miners and stokers and people whose work causes them to sweat heavily sometimes suffer from cramps. These painful muscular contractions are a sign that the muscles are short of salt.

The body does not get short of water, because the thirst induced by the sweating causes the man to drink freely, but he has no means of knowing that with the sweat-water he has also lost salt, which a drink of water cannot replace. We have learned now to prevent these cramps by adding a little salt to the drinking water which is supplied for such workers.

Skin Excretion

As an organ of excretion the skin removes, on an average, twenty-five ounces of water in the twenty-four hours (this is naturally variable), a little carbon dioxide, and quarter of an ounce of salt, with traces of protein waste matter. In comparison, the lungs excrete ten ounces of water, no solids and twenty-five ounces of carbon dioxide; and the kidneys, fifty-three ounces of water, a little carbon dioxide, an ounce of salt, and an ounce and a quarter of protein waste matter.

The skin shares with the muscles the function of being the reservoir of the body; the muscles contain four hundred and eighty-two grammes of water, the skin contains one hundred and twenty-six, while the whole body contains only six hundred and ninety grammes.



MAIN BLOOD-VESSELS OF THE BODY

The veins and capillaries bring the blood to the heart from all over the body. Thence it passes to the lungs to be purified, after which it re-enters the heart, leaving through the aorta, or main artery, on its journey round the body again.

CHAPTER FOUR

BLOOD CIRCULATION AND BREATHING

Early theories on heart and blood-vessels. William Harvey's discoveries. Construction of the heart. Circulation of the blood. How oxygen circulates with the blood. Functions of red and white corpuscles. How the heart beats. Blood pressure. How we breathe. Composition of lungs and windpipe.

THE functions of the heart and blood-vessels have from earliest times occupied the attention of anatomists, and by the end of the sixteenth century most of the anatomists of that time were satisfied that they knew all there was to know about them.

In the first place, they asserted, the blood was manufactured or concocted in the stomach out of the food, and went from the stomach to the liver by the portal vein. The liver transformed the blood into "real" blood, that is to say, blood endowed with "natural spirits," fit to nourish all parts of the body.

Anatomists (dissecting pigs, or the rare dead human body that came their way) had never seen the direction of flow in a living vessel; they pointed out two great veins that issued from the liver and said that the upper one took the blood to nourish the upper half of the body, passing on its way through the right auricle of the heart (for no particular reason), while the lower one nourished all the lower half of the body.

We now know that the great vein which reaches the liver from below is conveying blood from the lower part of the body to the right auricle, whence it will pass to the right ventricle and thence to the lungs for oxygenation. The blood in the great vein coming to the liver from above is not going from the liver to the tissues, but is a continuation of the great vein from below and is taking the same blood on from the liver level to the heart level. Nothing happens to this blood in the liver at all.

When the old anatomist went on with his lecture he spoke of the heart as the source of both light and heat, and saw in it a vital retort in which the "spirits" of life were concocted, to endow the blood with life.

The aorta, the great channel opening out of the left ventricle, he always found empty in his dead bodies, because it has a good deal of elastic tissue and muscle in its walls and therefore its last action before death is to drive the blood further on. The old anatomists therefore thought that this vessel, and the arteries which opened out from it, conveyed a vital spirit but not any blood.

Every part of the body, therefore, had two vessels going to it: arteries

which conveyed spirit, and veins which conveyed blood. The heart could only do its job if it was freely supplied with blood and air. It received the air from the lungs by means of certain vessels (called the pulmonary arteries and veins) which conveyed the air to the left side of the heart. Obviously, if a man choked, the air could not reach the heart, vital spirits could not be concocted, and he died.

Admittedly, the air and blood had somehow to get to both sides of the heart, despite the lack of any communication, but this was explained by supposing that there were invisible pores from which they exuded as sweat does from the pores of the skin.

Some anatomists admitted that there was blood as well as air in the aorta and arteries, but they still maintained that there was none in the pulmonary vessels; the arteries sucked blood out of the tissues of the body and then contracted and forced it back again, ebb and flow, like the sea tides.

William Harvey's Researches

The reasoning seemed quite consistent, but it did not satisfy a certain young student named William Harvey, who went to Padua to study at the end of the century. There he attended lectures by a famous teacher called Fabricius, who demonstrated the structure of the valves in the veins. To his astonishment Harvey found that they were so arranged at frequent intervals all down the vein channels, as to prevent a flow from the heart to the tissues. How then, he wondered, did the blood flow in the proper direction?

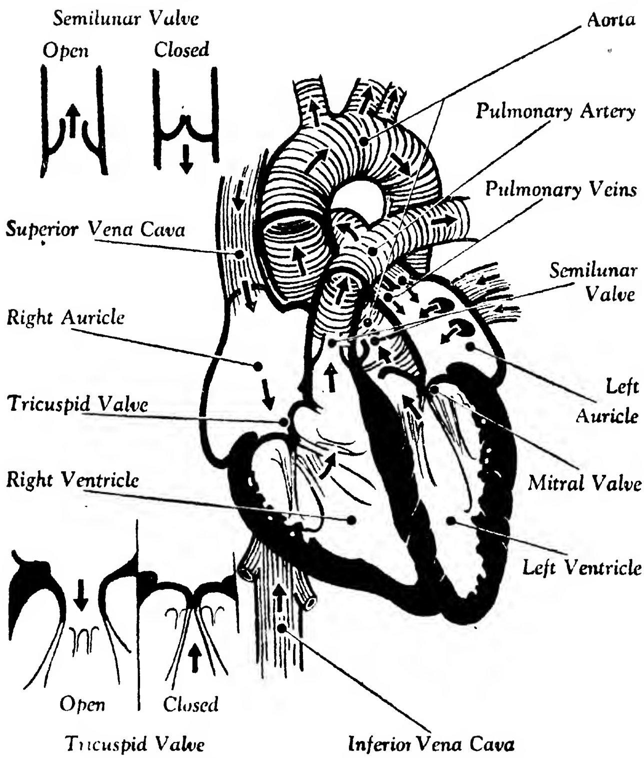
When he returned to England, Harvey continued his teacher's researches and boldly proclaimed that the old ideas were all wrong and that the right ventricle was a pump which forced the blood up the pulmonary artery through the lungs, to return to the left side of the heart by the pulmonary veins. He dissected all kinds of animals and he even experimented on the veins of his own arm.

Discovery of Blood Circulation

Finally, in 1628 he published his famous book, *An Anatomical Disquisition on the Motion of the Heart and Blood in Animals.* He described there the circulation as we now know it and only left one point unproven. That was how the blood got through the tissues from the arteries into the veins.

For this the microscope was needed, and the development during the seventeenth century of the primitive lenses hitherto used made possible the discovery by Malpighi in 1661 of the tiny vessels (the capillaries) which connect the two systems. These little thread-like canals may be less than one three-thousandth of an inch in diameter. Indeed, they may be so small that the blood-cells have to be compressed into a sausage-like shape in order to squeeze through them.

In the light of these discoveries, and of modern research, we can



STRUCTURE OF THE HEART

The heart is like a hollow bag divided into four compartments—two auricles above and two ventricles below. The auricles communicate with the ventricles of the same side through a valved opening, but there is no communication whatever between the left and right sides of the heart after birth.

consider in detail this intricate system which supplies the nutriment and air vital to our bodies.

The centre of the circulatory system is, of course, the heart, which, by its ceaseless and rhythmic pumping, drives the blood on its endless course throughout the body from birth to the end of life. Yet this tireless organ appears, to the ordinary eye, to be simply a hollow muscular bag, divided into four compartments. It lies almost in the middle, though slightly to the

left, of the chest, behind the breastbone and resting on the lungs.

As every one knows who has eaten sheep's heart, its thickness is made up of muscle fibre, which is very much like the flesh of any other part of the body. Actually, when studied under a microscope, the heart muscle fibre is seen to be intermediate in structure between the voluntary striped muscles of the limbs and the involuntary unstriped muscle of the intestines. Chemically, it contains more water, sodium, calcium and glycogen than striped muscle.

The muscle is lined by a shiny smooth membrane, which is the same as that which lines all the vessels proceeding to and from the heart. This ensures a smooth flow of the rather sticky blood, with as little friction as possible.

Protective Water-bed

Outside, the heart is protected by a water-bed and a tough covering. The water-bed is a double layer of thin smooth tissue in which there is always a little fluid, so that the two layers slide smoothly on each other and minimize the risk of any shock from outside, while also enabling the heart muscle to change the shape and position of the organ rhythmically and smoothly.

If there is any inflammation in this layer, so that there is more fluid than there ought to be, or the surfaces have become rough and jar on each other with each heartbeat, the disease called pericarditis has developed.

The tough covering is a loose bag of fibrous tissue, attached lightly to the breastbone in front and firmly to the diaphragm below.

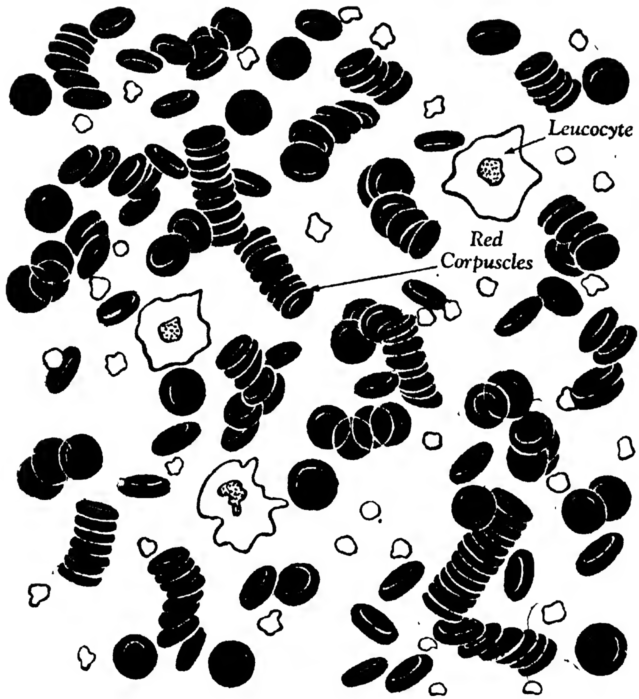
The four chambers consist of two auricles above and two ventricles below. The muscle is much thicker in the ventricles than in the auricles and it is from them that the powerful thrust of the heart cômes. There is no communication between the right and left sides of the heart after birth.

Valves of the Heart

Before birth there is such an opening, because the blood has to communicate through the navel with the mother's circulation instead of going to the lungs. This opening is closed at birth, but occasionally, through some error of development, it remains open and then the child suffers from a form of congenital heart disease.

Each auricle communicates with the ventricle of the same side through a valved opening. These valves consist of cupped disks of fibrous tissue—three on the right and two on the left—attached round the circumference of the opening, with their free edges meeting, as swing doors meet, to close the aperture. When blood is passing through, the valves are swung back similarly against the walls.

On the lower or ventricular side of the valves are attached a number of fine fibrous threads which link the valves to fleshy protuberances from the wall of the ventricle near its pointed lower end. These, being



HOW BLOOD LOOKS UNDER THE MICROSCOPE

Blood consists of red and white corpuscles and a number of small bodies called platelets, all of which float in a clear, almost colourless, fluid known as plasma. The red corpuscles are about five hundred times as numerous as the white corpuscles, one variety of which is called leucocytes.

muscular, contract to pull the valves open when a flow of blood into the ventricle from the auricle is required.

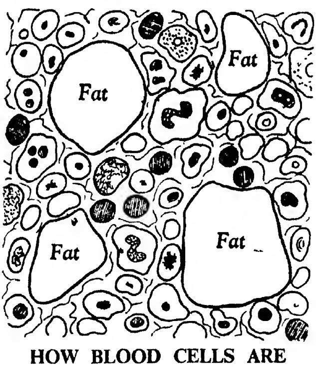
As the ventricle fills up, the blood in it presses the valves firmly shut and stops the flow. This happens with every beat of the heart. At the next beat, the blood which has thus flowed into the ventricles is pushed out into the great arteries, the aorta rising from the left ventricle and the pulmonary artery from the right ventricle.

The auricles are supplied with blood by the great veins, those from the lungs entering the left auricle and those from the rest of the body

entering the right auricle. The heart passes through alternate and rhythmical phases of contraction and relaxation which are called respectively systole and diastole.

The blood is a slightly sticky fluid, consisting of water with a number of chemical substances dissolved in it. It is the universal postal or carrier system of the body, and everything which is manufactured in one place and used in another has to pass through the circulation in a state of solution.

The only exception to this is oxygen, which is needed in every tissue all the time and is obtained from the lungs. There is some oxygen carried in solution like everything else, but it is so small an amount as to be ludicrously disproportionate to the immense demands for this commodity which are made by the vigorous tissues of a warm-blooded animal.



HOW BLOOD CELLS ARE MANUFACTURED

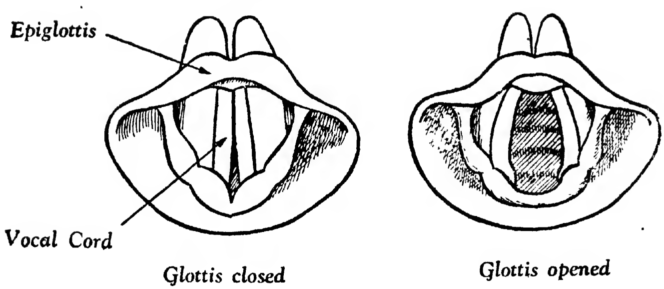
The red corpuscles and some of the white corpuscles are manufactured in the bone marrow, a section of which is shown above. Fat cells are distributed among the ripening red corpuscles (the round shaded cells) and the irregular white corpuscles.

Red Corpuscles

A special oxygen-carrying raft system was therefore devised for the sole purpose of distributing oxygen swiftly and regularly at all times. The special rafts are the red blood corpuscles, which are made from cells in the bone marrow. The immature forms are cells with a nucleus, but the final product has lost its nucleus, so that it is no longer a true cell, and looks like a tiny round biscuit which has been pinched in the middle. It has a yellowish-red colour which is due to the special substance, hæmoglobin, in which the oxygen is packed.

This is a complicated substance made out of iron, and attaches oxygen to itself when the oxygen pressure is high, but lets it go again and catches hold of carbon dioxide instead when the oxygen pressure is low and the carbon dioxide is high. It is like a bus conductress in war-time, who will take on only munition workers at the peak hour when munition workers are crowding the bus stop, but will deposit the munition workers at the terminus and on the return journey take on other civilians.

In the lungs the oxygen pressure is relatively very high, and therefore the hæmoglobin rafts draw the molecules of oxygen out of the air and load up with it. The substance is then called oxy-hæmoglobin.



VOICE-BOX WITH VOCAL CORDS

The voice-box is situated at the top of the windpipe and the air passes through it on its way down to the lungs. The passage of air is in no way impeded because the voice-box is held open by stiff cartilaginous walls.

They are whisked away by the current and conveyed to the tissues, where every cell which has been working has been using up oxygen and producing carbon dioxide. Here, therefore, the oxygen pressure is low and the oxygen is released from the hæmoglobin and delivered to the cells that need it.

At the same time the unloaded rafts are quickly loaded again with the carbon dioxide, forming carboxy-hæmoglobin. The capillary current conveys them on to the veins and finally back to the lungs, where the process starts again. Because oxy-hæmoglobin is red and carboxy-hæmoglobin purplish, the blood in the arteries is bright red, while that in the veins is bluer. (Physiologically, we all have blue blood in our veins—but not in our arteries.)

To trace the circulation through the body, let us join a molecule of oxygen in the air and see where it takes us. We start at the nostrils and pass rather slowly between the soft, warm, spongy banks of the nasal passage. As we go along here we are warmed up to body temperature through our contact with the blood in the nose-lining around us. The channel is rather tortuous to bring us into close contact with it.

If we had the misfortune to be drawn in through the mouth instead, we do not get nearly so warmed up, and we also tend to carry on with us certain impurities —perhaps even disease germs— which would have been filtered out in the nose. In either case we reach the top of the voice-box at the back of the mouth and pass down through that and the windpipe to the upper part of the chest, where the windpipe divides into two bronchi, right and left.

Our passage is quite unimpeded, because the voice-box is held open by stiff cartilaginous walls, and the

ring shape of the windpipe and bronchi is maintained by incomplete hoops of cartilage which surround the wall at intervals.

When we reach the substance of the lung the bronchi lose their stiffening hoops and divide and divide again until they are very tiny channels indeed. If we are fortunate, we shall still have no difficulty in getting along, and we shall find ourselves assisted by the cells lining the bronchi, as they have long, slender, hair-like processes called cilia, which wave us on, keeping up a current in one direction only.

If we are not lucky, we may find that there is an inflammation in the lining of the passage which makes it rough and sticky with inflammatory exudate. In that case the person whose lungs we are entering has bronchitis. The smaller the bronchi which are inflamed, the more obstruction there is to our passage, and the more likely we are to be thrown back by a sudden convulsive effort to get rid of the sticky exudate which irritates the lung; in other words, by a cough.

Inside the Lung

If all is well, the end of the narrow passage opens into a little space. This is the alveolus of the lung. If a patient has pneumonia, we shall find no open space but only a solid traffic jam of air trying to get in and exudate trying to get out. Then we can only abandon our journey and hope, for the patient's sake, that other parts of his lung are less congested, and that oxygen can get in somewhere, for if he is completely deprived of it for three minutes he will die.

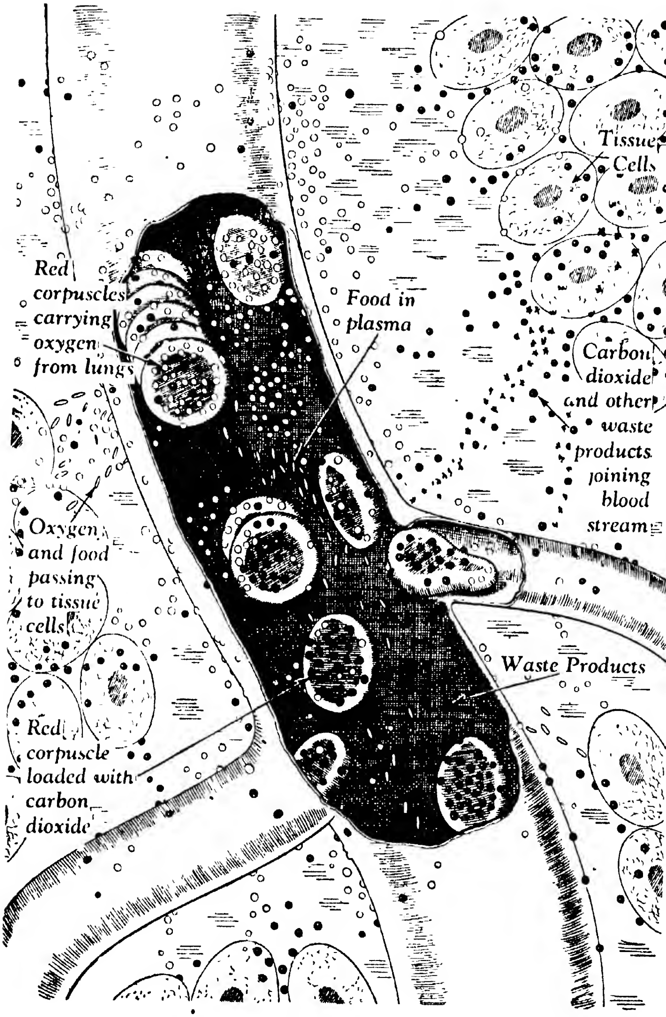
In a healthy lung we find that this little waiting-room is lined by a very thin cell layer, on the other side of which tiny capillary vessels of the lung are slowly conveying hæmoglobin rafts. Our oxygen molecule has no difficulty in passing between the cells into the capillary canal, where he at once boards a red-corpuscle raft, together with millions of others like him.

White Corpuscles

The raft meanders along the capillary slowly at first, like a barge on a canal, but gradually the pace quickens as more and more capillaries run together to form wider and wider channels, which eventually are called veins.

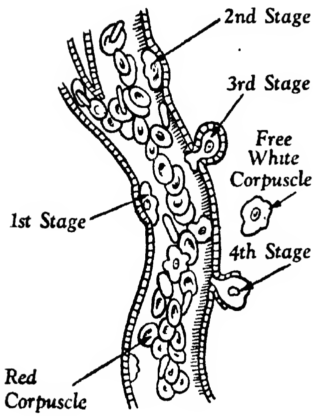
We find ourselves then moving on the raft with a relatively swift current among many thousands of similar rafts and many hundreds of white blood corpuscles, which are busy on their own affairs, policing the blood stream and its banks, looking out for debris, dead tissues or enemy invaders, which they will arrest and carry off to the police stations in the lymph glands if they cannot deal with them themselves by the simple process of eating them up.

The fluid in which we are floating is called plasma. It is rather sticky, and heavier than water, because of the many things dissolved in it. It contains all kinds of mineral



WORK OF THE RED CORPUSCLES

Red blood corpuscles bring oxygen through the capillaries to the tissue cells and return to the lungs loaded with carbon dioxide and waste products.



GUARDIANS OF THE BODY

This section through a capillary shows, in four stages, how the white blood corpuscles, which attack and consume germs and other invaders of the blood stream, escape through the capillary walls into the lymph.

salts, food-stuffs, and the secretions of glands, all, in a chemical sense, labelled with their destination, so that they are thrown out of the blood stream on to the banks wherever they are wanted, as an official throws out mail-bags from a non-stopping train as it passes through a station.

There is not very much of this traffic, however, in the first part of our journey, which leads us from the lung to the heart by a large short channel called the pulmonary vein. Our vein takes us to the left auricle, where we are stayed a moment, as river traffic is stayed at a lock, until the moment of systole of the heart, which allows the traffic in the lock before us to empty from the left auricle into the left ventricle.

Then we can enter the left auricle, and again are stayed awhile until the next systole, when we pass between the lock gates or valves into the left ventricle. When the left ventricle is full, the lock gates swing to behind us and we find ourselves in a relaxed but very thick-walled muscular chamber where we wait while the heart pauses in diastole.

Then a tremendous convulsion seizes the walls of our ventricle and it acts like those rooms in nightmares and horror stories which suddenly become smaller and smaller. We are not, however, destined to be crushed, any more than the hero of the story, for we see a three-valved opening swing wide for us from the upper part of the ventricle, and we push through into the first part of the aorta.

The gates swing to behind us, but we are not allowed to rest long, for the walls of the aorta itself are muscular and keep us moving steadily on with a series of rhythmical propulsions corresponding to the heart-beat.

Thus, we travel first upward and then down again in a great loop, round the arch of the aorta in the chest, and then down on the front of the backbone, behind the diaphragm. Here we are protected from interference by the regular contractions which the diaphragm makes in breathing, because the

aperture through which we pass is arched over by a tendon-band which does not contract.

Soon we shall have to make a choice. Already, at the height of the arch, we have missed three opportunities of leaving the main channel, where the great arteries to the head and arms branch off. Now in the abdomen, the aorta rapidly loses size through giving off big branches to the organs, as well as to the tissues of the body cavity. At the lower end of the spine it finally divides into two, one branch going down each leg.

If we decide to journey to the right great toe, we shall follow the right branch down the thigh to the knee, where it divides again, and we

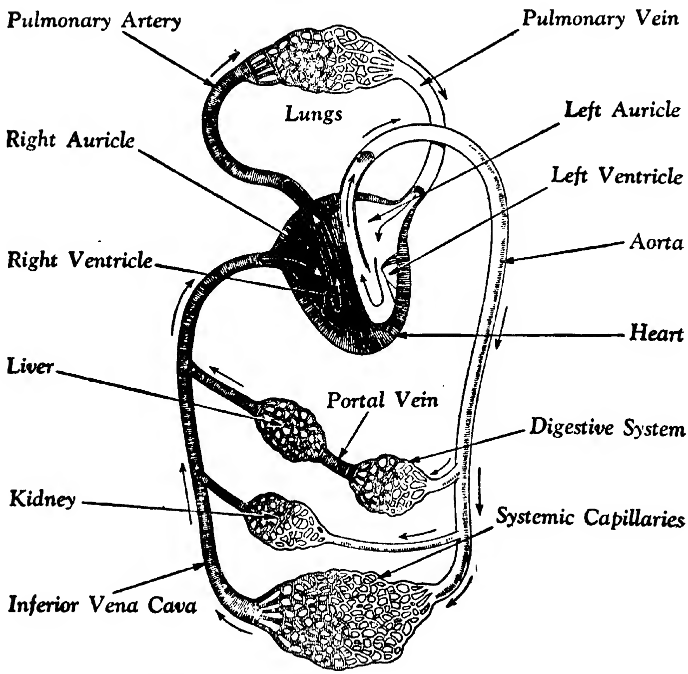


DIAGRAM SHOWING BLOOD CIRCULATION

This diagram shows how the blood is carried to the lungs, heart and principal organs of the body. The main veins are on the right of the heart, and the main arteries on the left. The large capillary networks are indicated where the lungs and other organs would roughly be situated. (*See also page 78.*)

must choose whether to go in front of, or behind, the leg, according to whether we want to go to the top or the underside of the toe.

Having eventually reached our destination, in an ever-narrowing channel, we find that our canal no longer deserves the name of artery, or even of arteriole (small artery); it is a little capillary with its walls made of a single layer of flat cells. It may be so narrow that the raft is distorted in squeezing through.

There is now no longer any muscle or connective tissue in the banks, but nevertheless these little canals dilate or contract in response to the chemical composition of the cells around them, and also in response to telephone messages along the nervous system. The rate of flow is now much slowed down, and we seem to creep along, with a constant and busy interchange of goods at the canal-side wharves, that is, the cells of the tissues through which we are passing.

Circulation in Veins

Eventually we come to the wharf which might be pictured as having a sign "Oxygen Molecule No. So-and-so to be deposited here," and then, if we are to stick to the raft, we lose the molecule with which we started. It goes off to keep going a tiny fire in a muscle or connective tissue cell and to lose its identity in the process.

We continue to meander along through exactly the same kind of country, but a great change has taken place. We are now on the venous side of the circulation, as we signalize by our change of hue from bright pink to bluish-purple.

Presently the channel begins to broaden out and the pace to quicken, and more channels constantly join us, until we can say that we are in a vein. We run back along the foot and leg, side by side with the arteries which brought us down, but we do not have that exhilarated sense of being pushed along by rippling muscular walls.

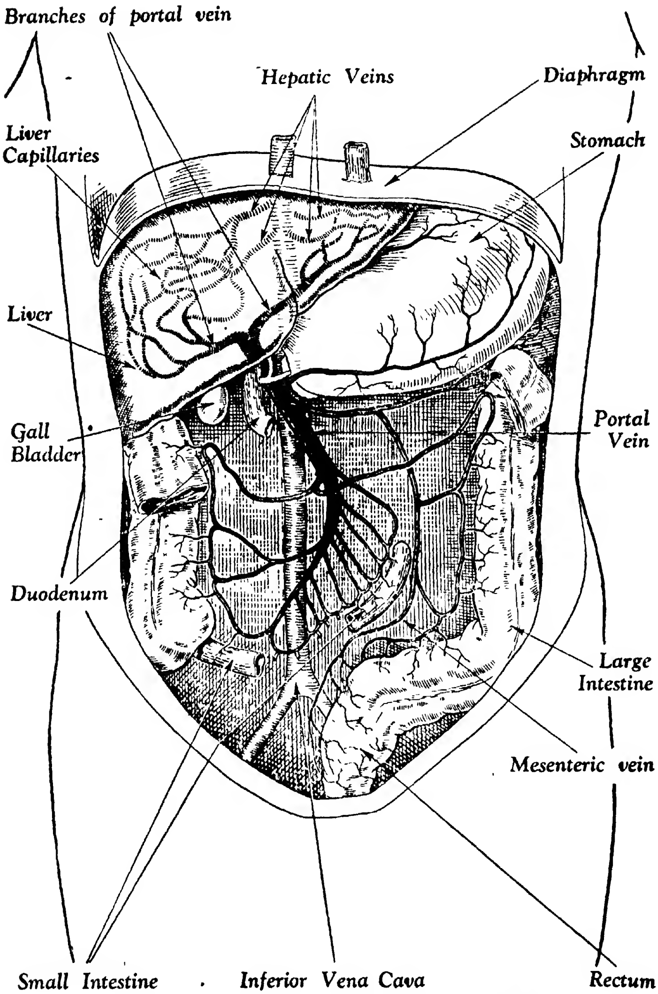
Valves of the Veins

Instead, we proceed sluggishly in a series of short rushes, which very largely depend on the pressure exerted upon our channel by the muscles which surround it. Thus, if there is no muscular activity our channels tend to get congested.

At frequent intervals we pass through lock gates or valves, which do not hinder our upward passage, but prevent us from slipping back again when the pressure ceases and gravity would tend to pull us down to the toes.

In this way we gradually proceed up the leg, being joined by more and more carbon dioxide-carrying rafts from tributary vessels, until we join the fellow vein of the opposite leg in the lower part of the abdominal cavity, and then run up beside the aorta.

We pass alongside the great liver factory, and receive from it a tremendous contribution which contains all the food-stuffs which have passed through its processes on their way from the alimentary



PORTAL SYSTEM OF DIGESTIVE ORGANS

The blood from the stomach, intestines, spleen and pancreas runs into the portal vein, by which it is conveyed to the liver and thence to the heart.

tract. We now pass through the diaphragm, where again we are protected in the same way as when travelling through in the aorta. This brings us up to the heart again, where we enter the right auricle, and then the right ventricle, in exactly the same series of systoles and diastoles as in the left auricle some time ago on our journey.

From the right ventricle we are pumped along the pulmonary artery, and find ourselves running along the outside wall of an alveolus on the other side of which are the eager oxygen molecules jostling to join our raft as soon as it has given up its load of carbon dioxide. Joining a carbon dioxide molecule as it leaves our raft, we find ourselves pushed back along the bronchi, windpipe and voice-box, and out through the nose or mouth back to where we started.

Problem of Pressure

Our experiences on this journey have shown us that the circulation is like a pump with a wide ramification of tubes, becoming smaller and smaller as they are farther from the pump itself. The problem is like that of supplying the inhabitants of a hilly city with constant supplies of water. For this, the engineer must maintain a head of pressure.

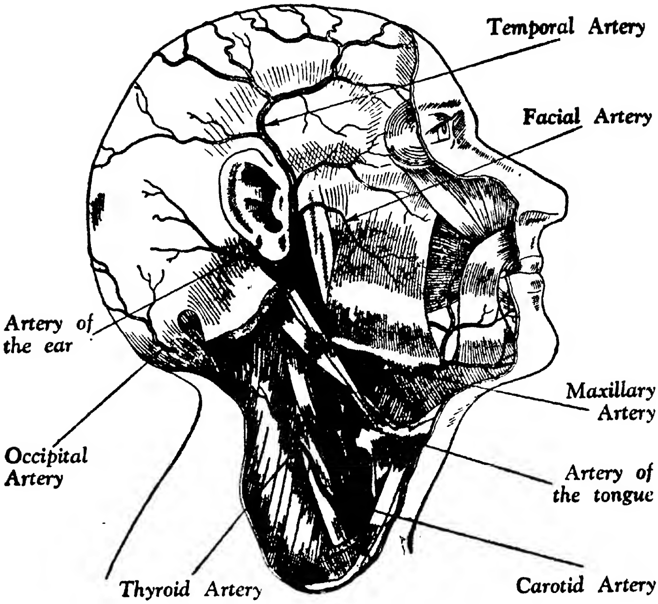
The first difference is that the tubes or pipes of the body are elastic, not rigid. All force pumps have a jerky flow, and the engineer, in order to supply a steady stream *of water, leads the pipe from the* pump into a closed chamber containing air. This air can be compressed to varying degrees, as it exerts less pressure than the water. Therefore the water leaving the air chamber has a steady flow, the jerk being absorbed by the air cushion. In the circulation the air chamber's function is provided by the elastic walls of the pipes. This method, however, puts a little extra work on the pump, which has to expand the great elastic vessels which lead from it.

How the Heart Beats

The second difference is that the pump, or heart, has no separate plungers or pistons. The problem of emptying a thick-walled vat without a plunger or a piston is dealt with by arranging tens of thousands of muscle cylinders in overlapping spirals, so that when they contract they do so in a converging manner, with the result that the contents of the chamber are thrust out.

The problem of how this remarkable pump is driven puzzled physiologists for very many centuries. The system certainly seemed to be under nervous control, like all the other muscles, and yet the heart-beat continued when all the nerves were cut, and the newly developed heart of an embryo chick in an egg beats before the nervous system is developed at all.

Another suggestion made was that the impulse to beat came from the blood inside the heart. But this



ARTERIES OF THE HEAD

Blood is pumped up to the head and brain from the great main artery (aorta), through the carotid arteries leading from it and thence through several smaller arteries. The veins of the head run almost parallel with the arteries and most of them bear the same names as the corresponding arteries.

cannot be wholly true, because a heart can be cut out of an animal's body, set up on a laboratory bench and supplied with a suitable fluid, and then it will go on beating. Moreover, strips cut from the ventricle and completely isolated will continue to beat for several minutes.

Eventually, workers on the heart found a peculiar piece of tissue in the upper part of the right auricle, and found that from this the beat started and spread all over the heart, in all directions, like ripples from a stone thrown into a pond, or as a broadcast radiates. This curious tissue has been called "the heart of the heart," or more usually, the pacemaker.

This discovery did not, however, solve the question, for no one has yet found out why the pacemaker has this remarkable quality. It is from this tissue, nevertheless, that the rhythmic contraction sets out,

roughly seventy-two times in a minute for perhaps seventy, eighty or even a hundred years, and the impulse spreads rapidly through the heart, similar to an electrical current, stimulating the contraction of the muscle.

Pace of the Heart-beat

As it passes across the auricle, via the auricular muscle, the impulse picks up another node of curious tissue lying at the base of the right ventricle; this is called the auriculo-ventricular node, and from this a bundle of peculiar fibres—something between nerve and muscle—runs to the top of the wall between the two ventricles and there divides into two, one running down on each side of the partition, and at the bottom spreading out into the muscle of the ventricles.

In the auricular muscle the impulse runs a thousand millimetres a second, but it is slowed down to two hundred millimetres a second in the auriculo-ventricular node, and then flashes down the rest of its journey at four thousand millimetres a second. In the muscle of the ventricle, however, it travels only four hundred millimetres a second.

This is not quite the whole of the story, for even if the auriculo-ventricular node is blocked so that the impulse from the pacemaker cannot get through to the ventricle, the ventricle does not stop beating for long, but goes on contracting at a very much slower rhythm. So it seems that the ventricle muscle has an inherent power of rhythmic contraction which is far too slow for the active life of the mammal and, therefore, the quicker rhythm of the pacemaker was superimposed.

Even so, the pace set in this way needs to be variable to deal with the varying conditions and problems of life, and therefore the pacemaker itself is subjected to control by the nervous system. It is not, of course, trusted to the voluntary nerves; nature never allows man's intelligence to take charge of anything really important to his life!

There are on record a few cases of peculiar people who could by will alter the rate of their heart-beat, or even stop it altogether for a short time, but for most of us the control is quite outside consciousness. It is part of the function of the autonomic nervous system (see page 146). The sympathetic part of the system quickens the beat; the parasympathetic part of the system slackens the heart-beat.

Experiments on Isolated Heart

A number of other factors also influence the rate of beating. They are studied in the isolated heart on the laboratory bench. The fluid which is run into the cut-short veins of such a heart must resemble blood plasma chemically; it must contain enough salt (sodium chloride) to give the fluid the same chemical pressure as that within the cells of the heart. It must also contain calcium, potassium, chlorides and bicarbonates.

The sodium has a special task in maintaining and originating the heart-beat, and there will be no rhythmic activity without it.

Calcium seems to maintain the contraction, and the more there is of it, the better the shortening of the muscle fibres, but the worse their relaxation, so that at last a heart with too much calcium in the fluid going through it will stop in a state of spasm, because of the lack of the rhythmic interval between the contractions.

Factors Influencing Heart-beat

The potassium does exactly the opposite, increasing the relaxation the more it is added, until the heart stops in a state of complete diastole.

The bicarbonate must be present to make the fluid slightly alkaline. If it is not alkaline enough, the heart relaxes and beats feebly; if it is too alkaline the heart contracts forcibly but does not relax to let the blood flow into it during diastole. It is found that the heart works better if a little sugar is added to the fluid to feed the heart cells.

The temperature of the fluid should be at normal body level; cooling the fluid slows the heart and may stop it, while warming the fluid quickens the heart. Another factor that must be present is an adequate oxygen supply or the beat will become feeble or irregular.

The heart is the most efficient living pump known, and may pump out fifteen gallons a minute. In the early experimental days a clergyman, who was vicar of Teddington in Middlesex, thought he would like to see to what height the force of the heart could drive a column of blood against gravity. His name was Stephen Hales.

One of his difficulties was that he had no rubber tubing in those days with which to join up the eight-foot glass tube he proposed to use with the short piece of tubing which he was able to insert into one of the arteries of a horse's neck. He solved this ingeniously by joining the two tubes with a piece of a goose's windpipe. Then he found that the column of blood rose very nearly to the top of his eight-foot tube

If the tubes were connected with the artery of a man the height would be about sixty-four inches. This power, which will lift a column of blood in this way, is called blood pressure, and it is defined as the pressure which is exerted on the walls of the blood-vessels by the blood inside them.

Blood Pressure

People sometimes talk of blood pressure as if it were a disease, but no man could live without a certain head of pressure in his vessels, enough to drive the blood through the sluggish capillary marsh in the tissues. When blood pressure is disordered it is either too high or too low; usually too high. In health it varies from moment to moment, within narrow limits, as it must respond to the demands of life imposed upon it.

A head of pressure can be altered in two ways; by increasing the flow of fluid into the system, and this may be done either by pumping faster or by giving the piston (when there is one) a greater length of strike; or by decreasing the flow out from the system.

Altering the Pressure

Nature uses both these means. The beat of the heart can be speeded up through the activity of the sympathetic nervous system, or the outflow can be very much slowed down by narrowing the microscopic vessels of the arterial tree.

It is as if every muscle and organ had its own stopcock. Sometimes when people get out of bed suddenly in the mornings they feel dizzy. This is because the stopcocks for the lower part of the body, which have been wide open all night in the horizontal position, are not shut down quickly enough when the vertical position is assumed. Then all the blood flows down under the influence of gravity, and the head is left with insufficient blood, which causes faintness. In a healthy person the situation is adjusted in a moment, but people with very low blood pressure learn to get up very slowly.

Perhaps the most important single factor in the maintenance of blood pressure is what is known as peripheral resistance: the contraction of the tiniest arteries in the muscles and organs. When they are tightly contracted, it is more difficult for the blood to flow through them, and so the pressure in the whole system is raised; when they are relaxed, the blood gets through much faster and the pressure falls.

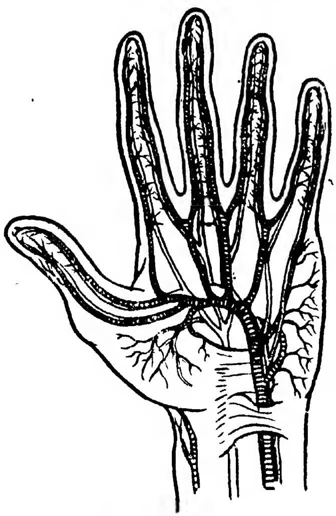
The muscles in these arteries are under the control of the sympathetic nervous system, which can act on very large areas or very limited ones, to produce a general or local rise of blood pressure. This in its turn is under the direction of a centre in the brain called the vaso-motor centre. The great interest of this centre is to maintain blood pressure at a steady level against all the shifting factors which might otherwise change it.

Work of Directing Centre of Brain

Therefore, if the blood pressure rises, the centre at once instructs the sympathetic nerves to relax their grip on the little arteries, and so the normal level is restored. Similarly, if the blood passing through the vaso-motor centre is at a low pressure, the centre will signal to the sympathetic nerves to squeeze down the arteries.

The centre is also sensitive to the oxygen and carbon dioxide content of the blood passing through it; if oxygen is short or carbon dioxide in excess it brings about a rise in blood pressure, with the idea that more blood will go to the lungs to be purified.

The sympathetic nervous fibres control the vessels in the abdomen and the skin, but very few go to the brain, the heart, the lungs, or the muscles of the skeleton. Therefore,



ARTERIES OF THE HAND

The arteries of the hand are a continuation of the radial and ulnar arteries of the forearm, forming an arch in the palm of the hand. The pulse is usually felt at the wrist, where the radial artery is very near the surface above the radius bone.

when the centre orders them to constrict the vessels under their control, the result is that blood is squeezed out of the skin and intestines, but not out of the brain, heart, lungs and muscles.

An enormous proportion of the blood in the body can be held in the vessels in the abdomen and skin. When it is squeezed out of them it must go somewhere, and so it goes to just those places where it is most needed if life is in danger and there must be rapid intelligent action to save the body. This is one of the most important warning mechanisms of the nervous system.

The vaso-motor centre is also sensitive to impulses coming to it from the brain; this means that the warning process can be set in action by emotions, and incidentally it explains why the skin goes white when a person is frightened.

Heart Sounds

When a doctor listens to your heart through his stethoscope he hears a sequence which is usually written as "lubb, dup, pause, lubb, dup, pause." These are called the heart sounds, first and second. The average time taken in one beat of the heart is about four-fifths of a second.

The first and duller of the two sounds is made by the closing of the valves between the auricles and the ventricles. As these valves close, the ventricles contract and blood rushes into the arteries; the effect of these other sounds added to that of the closing valve is to lengthen the noise and make it dull.

The second sound is made by the closing of the valves between the ventricles and the great arteries, and, being a simple sound, is shorter and sharper than the first.

It is when the valves are not working properly that these sounds become modified by what are known as murmurs. If a valve is inflamed, its shape is somewhat distorted and it ceases to be watertight; then the heart sounds are

complicated by the noise of the back-rush of blood through the imperfectly closed valve. This is a muffled rushing sound, rather like an indrawn breath, and may appear before the first sound or may muffle either of the two sounds, according to which valve is leaking.

Sometimes the doctor puts his stethoscope over an artery, but usually he tests the elasticity of the artery wall and the regularity of the heart-beat by putting a finger over an artery which conveniently lies between skin and bone at the wrist, that is, he feels the pulse.

Degeneration of Artery Walls

As age advances, the arteries tend to lose their elasticity, and sometimes to become rigid because of the deposition of lime salts in their walls in place of the degenerated elastic tissue. This condition is called arteriosclerosis, and, of course, the rigid vessels put up more resistance to the flow than do the supple ones, and therefore blood pressure is usually raised.

If it is raised so high, and the vessel wall is so weakened, that the artery actually bursts, there is a bleeding internally, which in the brain is known as a stroke. Alternatively, the artery walls may stretch at one point without bursting, forming a bag called an aneurysm.

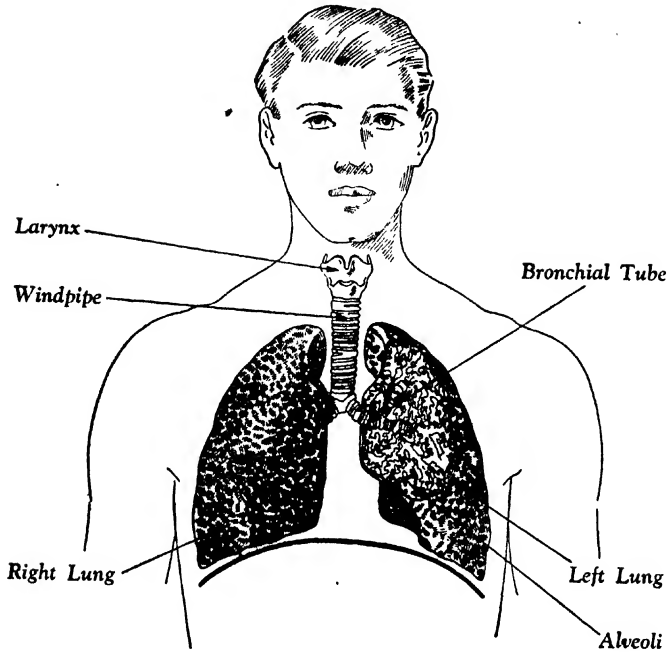
We have seen how the essential process of respiration is the exchange at the lung surface of oxygen for carbon dioxide in the blood. If you put a candle inside a closed vessel, the candle will very soon flicker and go out. If the fire is burning low and sluggishly, the natural thing to do is to blow at it.

These two facts show that combustion cannot go on without oxygen. In fact, the process we know as burning is chemically the combination of something in the fuel with oxygen from the air. It sounds strange to say that every cell in our body is burning all the time, but this is only because we think of burning as flaming. The process in the living cell is the taking in and combining with oxygen, and a certain amount of "ash," or waste products, is left as a result. The waste is the carbon dioxide gas.

The simplest organisms get their oxygen from the air or water in which they live, but with the advent of community life it is necessary to set aside certain cells for the special duty of oxygen carriers. We have seen that these are the red corpuscles, but, like any essential workshop, these depend on the activity of a great number of other workshops. The whole complicated function of respiration exists, therefore, to serve them.

Structure of Lungs

We have seen how the air passes from the exterior to the lungs. Each lung is shaped roughly like a cone and fills up almost the whole of one side of the chest. Each is divided by deep depressions into lobes, two on the left lung and three on the right lung.



ORGANS OF BREATHING

Air is taken in through the nose and travels down the windpipe and through the bronchial tubes into the lungs. The bronchial tubes branch, as shown in the cut-away left lung, until they eventually lead into the tiny air cells, called alveoli, of which the lung is chiefly composed. Among these air cells run the capillaries bringing the blood to be oxygenated and decarbonized.

The consistency is spongy, because of the air which is contained in tiny hollows, as in a very fine rubber sponge, and the colour is pink because of 'the abundant supply of blood. The lungs of those who live in large smoky cities gradually lose this pink colour and become streaked with black, though this does not affect the lungs. Each alveolus, or air cell, is about one hundredth of an inch in diameter, and there are about four hundred million of them in the lungs. Among these alveoli run the capillaries bringing blood to them.

Because the lungs, like the heart, are in constant rhythmical movement, they also are contained in a smooth, shiny water-jacket, made of two layers of slippery material between which is a little fluid. In this case the material is called the pleura. If there is inflammation the smooth surfaces become rough and rasp upon each other, or produce excess of fluid, and that is the complaint known as pleurisy.

With each in-breath the whole complicated tree of the lung system shifts at least half an inch, and in the lowest part the movement is at least three times as great.

How We Breathe

The movement of expansion is associated with a twisting movement rather like a corkscrew. When the muscles of inspiration—those which pull the ribs outward and upward—contract, the capacity of the chest is enlarged.

At the same time, the diaphragm descends, and this enhances the effect. This means that the pressure in the lungs is considerably reduced, because the amount of air in them at the beginning of the in-breath has to fill a much larger space.

There is thus a difference of pressure between the alveoli and the outside air. Since these two are connected through the nose and windpipe, there must at once be a rush of air into the lung until the pressure is equal again. In this way, the lungs are filled with fresh air from outside the body.

Both the chest and the lungs are elastic, and the action of inspiration is rather like that of blowing up a rubber balloon; as soon as the effort is relaxed, there is an elastic recoil and the air is forced out of the lungs again.

Expired Air

In the meantime, however, the busy workers on the wharves of the lung blood canals have seized their opportunity, and landed a cargo of oxygen and discharged a cargo of carbon dioxide, so that the air which goes out is very different in composition from the air which goes in.

Although expiration is normally a passive movement, it can be reinforced by certain muscles if necessary, as when attempts are made to expel some secretion or foreign body from the lung passages by coughing.

In the same way, if there is any obstruction to the entry of air, a number of muscles attached to the ribs can be called on to help, although normally their function is not respiratory. Most of these work from the ribs to the arms and, therefore, the elderly person with bronchial obstruction and the runner after a tremendous effort, help the entry of air into their lungs by fixing their arms (usually by clasping the thighs) so that the arm is a fixed point and the muscles work from that and pull on the ribs.

The lungs are much too large for an animal at rest or living a quiet life; they are designed to be

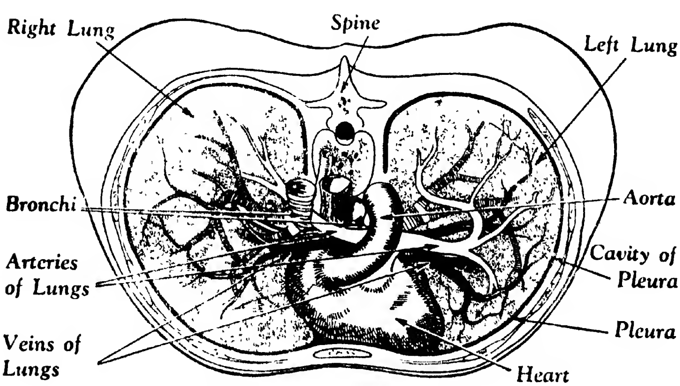
sufficient to supply its tissues with oxygen when they are putting forth the maximum of which they are capable. For a sedentary life one lung is quite enough, and many persons with a diseased lung have carried on for months or years while the other lung is put out of action for treatment.

In quiet breathing about five hundred cubic centimetres of air passes in and out, but with the deepest possible forced breathing another fifteen hundred cubic centimetres can be drawn in and an extra fifteen hundred centimetres can be forced out.

Of course, the lungs are never left entirely empty, and what is left in them after the biggest possible out-breath is called residual air. The vital capacity is the greatest amount that can be breathed in after the biggest possible expiration; it is about three thousand, five hundred cubic centimetres. This is what is measured when testing a man's capacity for exertion. It is about seven times the size of a normal breath, and varies with the size of the individual and with training. An athlete's vital capacity is greater than that of a normal man, and that of old people is less than that of the young.

At rest, a man absorbs about half a pint of oxygen a minute; when he is running fast he needs a great deal more, and can take in as much as seven pints a minute.

With bicycling and other forms of exercise, the intake is not quite



CROSS-SECTION THROUGH THE CHEST

This diagram shows the heart in relation to the lungs, the bronchial tubes, and the blood-vessels which carry the blood to and from the lungs. The space between the lungs and the chest wall is filled with fluid, which is enclosed in a smooth, shiny water-jacket made of two layers of slippery material called the pleura. This jacket protects the lungs and minimizes friction.

so great because the chest is more cramped by the position and the flow is impeded.

In a short sprint there is little or no increase in oxygen consumption, because of the capacity for running up an oxygen debt (see page 55). The sprint of a hundred yards, taking about ten seconds, costs about ten pints of oxygen, an amount which would just serve to burn up a lump of sugar.

The average number of breaths per minute is sixteen, though breathing is normally faster in both the young and old. It varies with any need for more oxygen.

At high altitudes the thinner atmosphere means that less oxygen enters the lungs and breathing becomes very rapid and deep. The lack of oxygen affects the heart and muscles, causing what is called "mountain sickness."

It is rather more under the control of the will than the heart-beat, but only up to a certain point. It is impossible to hold the breath for more than a few minutes; and when the tissues become really short of oxygen, nature once more takes over control.

Control of Breathing

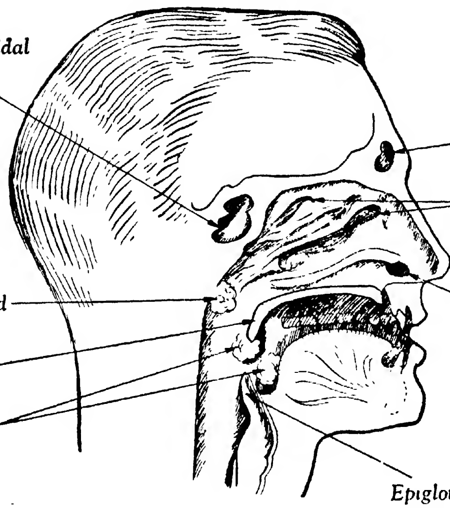
Breathing is controlled by a centre in the back of the brain and this centre is responsive to very many stimuli from various parts of the body. Like the centres concerned with the circulation, it effects its instructions through the autonomic nervous system. It responds to emotions, and to all kinds of messages from the skin and nose: for example, a pungent smell will temporarily inhibit breathing—in case it should mean some dangerous atmosphere—and a cold douche will temporarily inhibit it and then deepen it.

Breathing has to be stopped momentarily whenever food is swallowed from the mouth, because it would be terribly dangerous if food particles were caught in a current of air and carried down into the lung passages where they would obstruct and set up inflammation. This is done by a complicated muscular mechanism, part of the swallowing reflex described in the next chapter (see page 112).

Content of Air

But all these various factors have to be balanced by the centre against the predominant stimulus to breathing, which is an excess of carbon dioxide circulating through the centre. If there is too much carbon dioxide there is danger of cell deaths somewhere, not because the carbon dioxide is poisonous, but because its presence means that there is not enough oxygen.

Normally the air we breathe in contains only about 0·04 per cent of carbon dioxide, while the percentage of oxygen is 20·96. When we breathe out, however, the percentage of carbon dioxide from our lungs is just over 4 per cent, the percentage of oxygen falling in proportion to 16·4 per cent. The amount of nitrogen, which forms the remaining 79 per cent, remains



CAVITIES AND PASSAGES OF THE NOSE AND THROAT

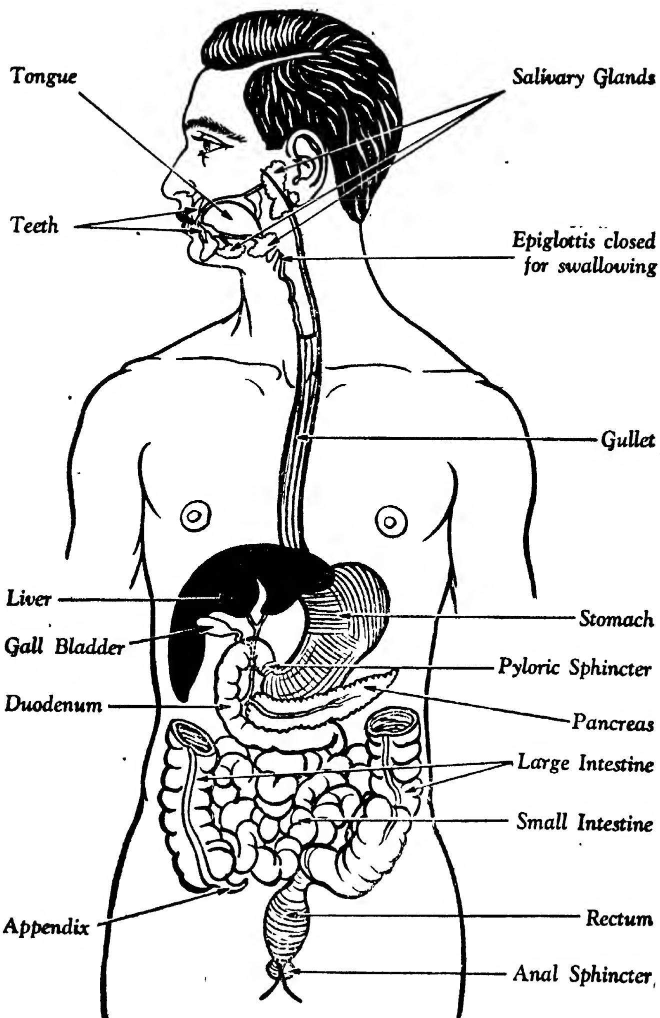
Air is filtered and warmed to body temperature on its way through the passages and cavities (sinuses) of the nose. Germs and impurities are collected in the hairs inside the nose and by the adenoids. When food is swallowed the epiglottis shuts to prevent it passing down the windpipe.

constant, since it takes no active part in the process of respiration and only about 1·5 per cent is found in the blood.

The air we breathe in also contains water vapour, the amount of which varies considerably. We are well aware of these changes. For instance, when we speak of a dry atmosphere, or of a "good drying day," the air has very little water vapour, while when the air is loaded we complain that it is a damp muggy day. When we find ourselves in the midst of a dense fog it means the air is charged with water vapour to saturation point.

Strangely enough, the amount of water vapour breathed in has no relation to the amount breathed out, for no matter how dry the outer air, that coming from our lungs is always saturated. The temperature of expired air also remains constant at body temperature (normally 98·4 degrees Fahrenheit).

This explains why we can " see our breath " in cold weather. The warm saturated air from our lungs meets the colder air outside and condenses, forming what is in fact a cloud in miniature.



ORGANS OF DIGESTION

The various organs through which food passes and undergoes all the transformations necessary to fit it for entry into the actual cells of the body.

CHAPTER FIVE

THE DIGESTIVE SYSTEM

Four main food groups. First stage of digestion in the mouth. How we swallow. Juices of the stomach. Work of the liver and pancreas. Passage of food through the small intestines. Waste products and excretory organs. Functions of the kidneys. Varying amount and composition of urine.

WALTER DE LA MARE once observed:

"It's a very odd thing,
As odd as can be,
That whatever Miss T eats
Turns into Miss T."

Very odd, indeed, it is; and not only is this process odd, but it is carried out by a most complex, fascinating and delicately balanced piece of mechanism. For not only has the food to be built up into Miss T; it has first of all to be broken down into the kind of bricks of which Miss T is composed. The digestive system is like an architect who is required to build a row of council houses and is given as material a telephone exchange, a town hall and a cinema.

All the processes that we ordinarily think of as digestion are just the housebreaking stage: the breaking up of the original buildings, the foodstuffs, into neat heaps of bricks, mortar, woodwork, electric wiring and so on. This takes place in the alimentary canal; the building up only begins when the food has passed out of the gut into the system.

All Miss T's diet, varied as it is, can be classified in four main groups: proteins, fats, carbohydrates and minerals. The proteins may be animal (meat of all kinds, fish, eggs) or vegetable (peas, beans, nuts). The fats and the carbohydrates are simpler compounds, carbohydrates including all sugars and starches. Minerals are simple compounds like salt.

Since protoplasm is a mixture of proteins, intelligent man would doubtless expect Nature to build up protoplasm by a supply of proteins. But Nature is not so simple as man would like her to be. Miss T's protoplasmic proteins are so peculiar to Miss T that nobody else's will do—not even if she turned cannibal and ate her nearest relatives. Even a slice of father or a saddle of Uncle T would have to be laboriously taken to pieces and broken down into bricks and mortar before Miss T's protoplasm could use it.

Therefore it really does not matter very much what kind of protein is used, so long as there is enough of it. Some protein is essential to life, for broken-down protoplasm can only be built up again from protein food. An adult body needs relatively little, like a completed house

—just enough to make good the wear and tear which inevitably goes on all the time. A growing child, like a house in building, needs very much more, because, with growth in size, new protoplasm has to be provided.

The fats and carbohydrates are of no use for replacing protoplasm but they are none the less essential, because they are used as fuel, and are burned up to keep the house warm and run all the machines that are needed for its many activities.

Stimulus of Smell

When Miss T sits down to her very mixed diet, her digestive organs are going to view it all with the eye of a sorting clerk and file it away.

They will then advise the breakdown gangs, who will arrange to have the right kind of breaking-up implements all ready before the food reaches them.

Some people think that digestion begins when the food enters the stomach, after being swallowed; others may think of it starting as soon as the food is bitten off. Both are wrong. It begins long before that. On the stimulus of smell alone, our mouths water and the water in the mouth is a digestive juice, getting ready for the food that is to come. And not our mouths only, but our stomachs, and even our small intestines are "watering," pouring out the juices that will be needed perhaps ten minutes, perhaps an hour or two later. In other words, we are beginning the process of digestion.

Everyone knows that other experiences besides smelling food will make the mouth water. These experiences were investigated by the great Russian scientist, Pavlov, in dogs. Dogs produce a lot of saliva, and he found it easy to measure the amount produced and so find out what made the water pour into the mouth. The sight of food would always do it, as well as the smell; but he was able to take it much further back than that.

If he fed his dogs regularly off blue plates, or at the sound of a bell, or a violin note, then very soon their mouths would begin to drip at the sight of a blue plate—though not at any other colour—or the sound of the bell or note, even when there was no food anywhere around to justify their optimism.

Many human beings have been aware of mouth-watering at the sound of a gong, and yet what is there in a loud noise to make a digestive gland get ready?

Process of Association

It does not seem to make sense but the sense is there, of course, and is based on the mental process of association: if two things happen together many times over, they become associated in the nervous system, and messages through the eye or ear can excite the digestive system just as much as the more direct and natural messages through the nose and mouth. It would be easy to provoke a flow of saliva in a baby by the simple act of tying on his bib in the midst of a desert.

When Miss T hears the clock strike, therefore, or stops for a moment in her work to think "Isn't it nearly dinner time?" or sees the maid passing across the hall with a tray, or gets a whiff of fish frying, then is the moment when her digestive processes begin.

Digestive Juices

The fluids that are provoked in these indirect ways, with no direct contact with food, are called psychic juices. They are important in good digestion, and their production varies very much with circumstances and the particular person concerned. Many social customs are based on the instinctive wish to get a good supply of psychic juices: all the paraphernalia of changing for dinner, laying tables, serving food daintily, gathering for a chat or a cocktail, and so on.

The psychic juices are much more powerfully stimulated by appetizing food, and that means food which appeals to the particular individual, for there is no accounting for tastes. What appeals to one may appal another, and a sense of distaste, or disgust, or repulsion means that there will be little or no psychic juice, with probably resulting poor digestion of the food.

Next, Miss T sits down to table and sees and smells the food on her plate. At once, there is a further abundant pouring-out of her juices. Then she lifts the food to her mouth and the actual contact with her tissues, and especially with the special organs of taste in her tongue, further enhances the process. She tears and grinds the food with her teeth, and if she is a good follower of Mr. Gladstone she chews each morsel thirty-two times.

This serves several purposes: it breaks the lumps down into small particles, detects any dangerous sharpnesses or rough edges which might damage the more delicate lining farther down, and thoroughly mixes the food with the saliva, which is the first housebreaking gang of the digestive system.

While this is going on, any tough rinds surrounding the food-stuff are broken down, so that the whole thing can come into contact with the saliva and taste buds.

A petrol tank can gratefully and indiscriminately receive the fuel poured into it; it may be said to trust its owner not to pour in anything which will be harmful to the engine. The human body has no such touching faith in the intelligence of its owner. It takes its own precautions, and puts the food through a gruelling examination before it allows it to enter the stomach where it might do harm.

Precautionary Food Tests

The first test is smell: many a bad mouthful has been rejected by the nose before it could do any harm. The next challenge comes from the lips. The skin here is very thin, and the nervous supply is sensitive, especially to temperatures, and no conscious person is going to drink a boiling fluid or a corrosive without having a sharp warning

from his lips which, even if damaged, are quickly and easily repaired, whereas a burn lower down may be dangerous or fatal.

Taste and Smell

But the noxious thing may be wrapped up in such a way that neither nose nor lip can challenge it, and then its disguise is removed by the searching teeth, so that the attentive taste buds may raise the warning. For every child who swallows a poisonous berry there must be hundreds who spit them out because they taste nasty.

The food has by now reached the back of the mouth (for the front of the tongue contains few taste buds), and so the savour of it reaches the nose again through the back door, where the nose opens into the throat at the back of the mouth. Taste and smell are generally confused, for nearly all the things we call taste are really smell.

If you put your tongue out at your reflection in a mirror you will see a V-shaped line across it some way back (see diagram on page 155). It is along this line that nearly all the taste buds lie; they are microscopic oval bodies, and they have the ability to distinguish four tastes, and four only: sweet, salt, bitter and acid. Every other taste is really experienced in our noses, by the sense of smell.

If the nose can be entirely blocked, back and front, and the solution to be tasted is just dropped on the taste buds, there will be no flavour of mince or apple or jam: just salt or bitter or acid or sweet. Those who have a bad cold can testify to the truth of this, for the taste buds are not in any way affected by a cold.

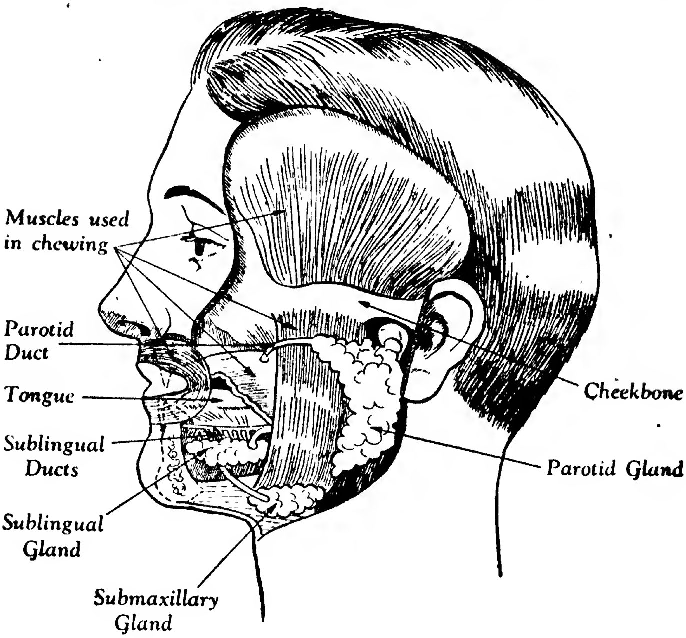
When the salivary firm of house-breakers is presented with fat or protein it merely looks the other way; it is concerned solely with attacking the carbohydrate, and of the carbohydrate, only the cooked starch. Therefore it is reasonable to assume that slow chewing of cooked starch is even more important than of the other food-stuffs.

The saliva cannot get at the starch unless it is well mixed in, and the juice of the salivary glands must, therefore, be well rubbed into the food by the movements of the tongue and jaws. Much of the starch in our food is contained in a husk of some kind and, unless this has been destroyed by preparation or cooking, the work of the saliva depends very specially on the action of the teeth.

Salivary Glands

The saliva is manufactured in six special factories, called salivary glands, arranged round the mouth: two beneath the tongue, two under the lower jaw, and two just in front of and below the ears.

The fluid these factories produce is 99 per cent water, which softens the food, so that it does not scratch on its way down, and dissolves the food if it is soluble in water. The digestive apparatus can only deal with solutions, so sooner or later every bit of food must be dissolved.



PRELIMINARY STAGES OF DIGESTION

Digestion actually commences with the desire for food stimulated by a pleasing sense of smell. The watering of our mouths is merely the presence of digestive juices from salivary glands arranged round the mouth, getting ready for the food that is to be chewed before entering the stomach.

The saliva also serves to keep the mouth moist for the tongue movements, and to wash the teeth.

The important substance in the saliva is the first starch-splitting ferment or enzyme called ptyalin. Enzymes are very peculiar chemical substances, only found in living things: they each exert an action peculiar to themselves on some other substance, without apparently undergoing any change. Yeast is the most familiar example of a living thing which produces an enzyme. It so alters the flour that a gas is produced and the bread rises; yet, because it does not take any part in the process itself, a minute quantity will do the work, and "a little leaven leaveneth the whole lump."

Most enzymes, as well as doing one job and one only, make certain demands before they will do their

work. Ptyalin, for example, must have a neutral or faintly alkaline solution in which to work. As a great chemist has said, enzymes and the substances on which they act are like a key and lock, and must be exactly matched if the door is to be opened.

When the ptyalin has acted on the starch in the mouth, it is still fresh and ready to begin on a new lot. A good deal of saliva is, however, lost to the economy through being swallowed with the food. When it gets into the stomach it finds itself in an acid environment and is then of no further use.

One of the strict conditions laid down by enzymes is the temperature at which they will consent to work. A scientist who wants to investigate the action of any of the human enzymes in his laboratory has to be careful to keep them at the temperature of the body; if they get too hot or too cold they will not work. For this reason digestion is often impaired during fever.

Changing Starch Into Sugar

However, if all goes well, and salivary digestion is completed satisfactorily, the starch in the food is turned into sugar. That is shown by the sweet taste of a well-chewed piece of bread. All carbohydrates must eventually be turned into sugar and an even simpler sugar than this in the mouth, because simple sugar is the only kind which the absorptive tissues will receive into the body. The sugar of the bowl on the table is a complex sugar and itself has to be broken down to a simpler form.

What happens to people who "bolt" their food? Nature is very, very careful; she always has a second or third line of defence against careless digestion. The second line of defence for salivary digestion is that it can, in certain circumstances, continue after the food has been swallowed into the stomach. It is true that ptyalin will stop work directly it comes in contact with the acid stomach juice, but the two can be temporarily kept apart in two ways.

Digestion of "Bolted" Food

In the first place, the early mouthfuls spread out and line the stomach wall, while the later mouthfuls pass into the centre of the mass, and so do not at first come into contact with the juice which is being poured out from the walls. Therefore saliva may continue splitting starch for some time even down in the stomach.

Secondly, if fat is eaten with the starch, it tends to spread out in an oily film over the stomach walls, and this film prevents the acid from getting at the food. There is an old story of a man who made his living by going into public houses and betting that he could drink enormous quantities of whisky without getting intoxicated. He always won his bets, because before going in he would eat a large quantity of butter; thus the whisky was sealed away from the stomach wall and did not get into his veins. When he

had collected the money he would go outside and vomit the alcohol.

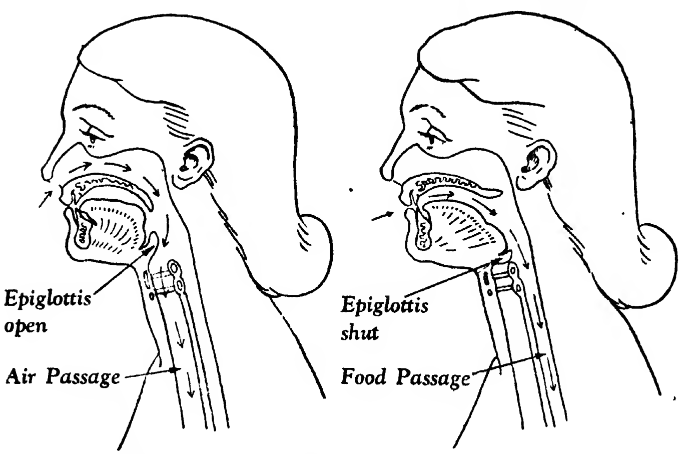
It is this action of fat which makes us feel more comfortable if we eat a fat with starchy meals: butter on bread, for example, gives more play to salivary digestion. New bread is more difficult to digest than stale because the saliva finds it difficult to penetrate into the compact doughy masses.

Starchy foods are best taken toward the end of the meal, so that the stomach walls are well lined and the juices employed with the earlier courses before the starch goes down. Hence pudding after meat.

Nature is very careful not to entrust to our conscious control any process on which our lives depend. She allows that the brain may be useful in testing the quality of the food by taste and smell and feel, but as soon as it leaves the mouth it is beyond any voluntary recall (save for the induced vomiting which some people practise to relieve the stomach or get back some undesirable substance swallowed by mistake).

The food, dissolved or moulded into a soft ball, is thrown by the tongue against the back of the throat, and at once an involuntary trigger mechanism is set to work, causing the food to pass quickly and inevitably into the gullet.

There is a special reason for this high-handed control here; by one of those curious anatomical arrangements that always tempt



HOW WE SWALLOW WITHOUT CHOKING

The opening of the windpipe lies in front of the gullet, and to prevent food going down the wrong passage, the epiglottis closes down for a moment every time we swallow until the food has passed safely over the danger point.

man to think he could have designed better, the openings of the gullet and of the windpipe lie close together in the throat, and the opening of the windpipe is in front, and thus more likely to catch the food than is the proper hole.

Yet if the food "goes down the wrong way" and gets into the lungs the results may be disastrous. The upper part of the windpipe is therefore doubly protected; by the involuntary and violent cough spasm which throws back any food reaching the inside of the voice-box at the upper end of the windpipe, and by the swift swallowing mechanism, which closes down the air passage for a moment, shoots the food past the danger-post like a flash, and sees it safely enfolded by the muscles of the gullet.

Structure of Stomach

The food now proceeds more slowly down the length of the gullet, and rests a little while outside the stomach, before slipping into it, distending it just so much as is necessary to hold it. The stomach is not like an empty saucepan into which food is poured. It is an elastic muscular organ, small and almost tubular when empty, stretching to accommodate its contents and always fitting snugly round them, whether a snack or an alderman's banquet.

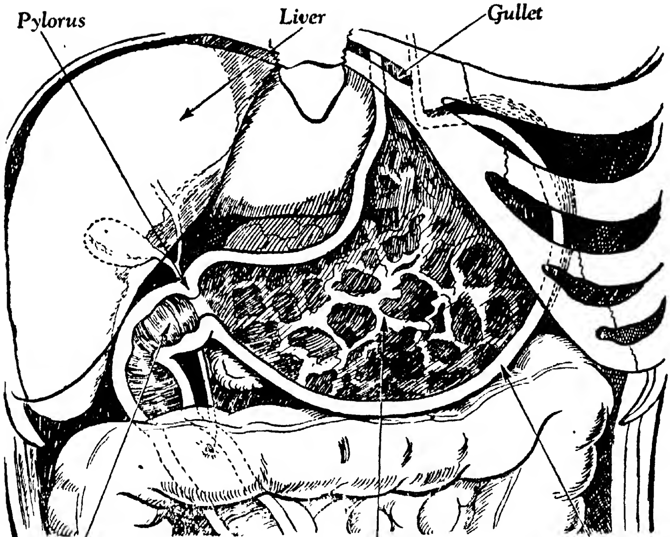
This capacity to fit the contents is the task of the muscles in the stomach wall and is called "tone." Tone is affected by quite a number of emotional factors and when tone is poor and the stomach is slack, the latter hangs low in the abdomen and digestion is impaired.

A radiologist once took a number of medical students who had just finished an examination and watched their stomachs under X-rays; if they were frightened their stomach tone failed; if they were roused to courage or adventure, the tone improved. He told them all that they had failed in the examination; those whose stomachs dropped at the news were held to be poor specimens, better rejected; those whose stomachs rose were the fellows who had "guts."

Muscles of Stomach

There are three layers of muscles in the stomach wall, and the fibres run in three different directions: up and down, round and round, and obliquely. When there is food in the stomach these muscles contract very gently all the time, and the effect is that the food is softly churned around and stroked, so that every particle of it is brought in turn into contact with the lining from which the gastric juice is pouring out all the time.

Sometimes the muscles undergo much more vigorous activity; this may be when the stomach is empty, and then its owner feels a pang of hunger. Sometimes, when the stomach is filled with something which irritates the nerves in the lining, the muscles gather themselves together and work upward, throwing the contents out of the



HOW THE STOMACH FUNCTIONS

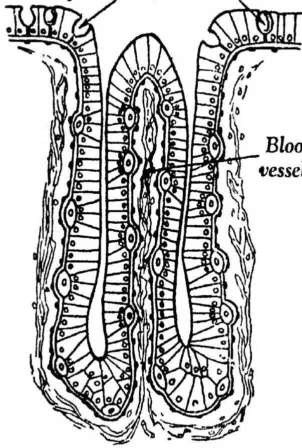
The stomach is an elastic, tubular bag, which stretches to fit the amount of food sent into it. It has three layers of muscles, which churn the food around so that every particle of it is brought into contact with the gastric juices.

stomach back into the gullet, with the result that they are vomited.

These nerves are sensitive to many ills, even to the disorders of other organs, and especially so in young children. That is why a vomit may be the herald of appendicitis or pneumonia or trouble in the intestine. The stomach has been called the "watchdog of the abdomen" because its sensitive nerves draw attention to dangers.

The lining of the stomach is the same soft, red, spongy stuff that lines the mouth, and scattered thickly through it are the special cells, called glands, which manufacture the gastric juice. This juice, like the saliva, is 99 per cent water. Quite a lot of the food that comes down from the mouth has not yet been dissolved, so more dissolving goes on as the food moves quietly within the stomach.

The special digestive substance supplied by the gastric glands is called pepsin; like ptyalin, it is an enzyme, but it differs in two



MEMBRANE OF STOMACH

The stomach is lined with a layer of mucous membrane, the surface of which is studded with cells known as goblet cells because of their cup-shaped appearance. Each cell produces one drop of mucus at a time.

respects. In the first place, it acts on proteins, not on starches; in the second place, it works only in an acid environment. To ensure this, the gastric glands also produce hydrochloric acid (spirits of salts); on an average, the juice contains about 0·02 per cent of this acid.

Several things provoke the pouring-out of this juice. In the first place there is a psychic flow, just as with saliva. Then it is stimulated by warmth and spicy foods, and for this reason a meal begins with soup, or with something tasty like hors d'œuvres. Such heralds encourage the stomach to pour out plenty of juice for that which is to follow, even though in themselves they need little or no digestion. The presence of food in the mouth stimulates gastric juice, and so does a drink of water.

Finally, there is a big production as soon as a meal actually enters the stomach itself, and juice is varied according to the nature of the food that comes in: meat, for example, calls out a concentrated juice, rich in enzyme.

The digestive tract gets into habits if the diet is restricted; a patient fed for long on milk, for example, gets in the way of producing a milk-digesting kind of gastric juice, and may be quite unable to digest another kind of food unless it is introduced gradually; similarly, if a baby is never fed on fat he may never learn to produce a fat-digesting juice.

The pepsin takes the complicated protein molecules and knocks bits off them, so that they gradually become smaller and smaller. The acid, in addition to providing the kind of background that pepsin likes, has also an antiseptic action, protecting the body against swallowed germs. A healthy gastric juice will kill almost any germ, but if the acid is weak for any reason, the germs may get through to the intestine and cause disease.

In the early days of germ discovery, people did not understand this, and thought that the presence of the germ automatically produced the illness. The story is told of a

professor who did not believe in germs and who strolled into the laboratory one afternoon with his teacup in his hand.

"What's this?" he asked. "That," they told him, "is a pure growth of typhoid bacilli. If you got that inside you, you would develop typhoid fever, and die." "Ha, ha! What nonsense!" laughed the sceptical professor, and, before any one could stop him, emptied the tube into his teacup and drank the contents.

All his colleagues stood around awaiting his "untimely death," and very discomposed they were when he remained hale and hearty, and more than ever sceptical of the germ theory of disease. But he owed his good health to the active acid juice in his stomach.

How Milk is Junketed

The stomach juice contains another enzyme called rennin, which most housewives have bought at the grocer's in order to make junket. The function of rennin is simply to make junket of any milk taken into the stomach.

The stomach also reinforces the mouth in regulating the temperature of the food, so that if tea is drunk too hot, or ice-cream is hurried down too cold, the temperature of both is brought to body-heat before the delicate intestine is entered. The organ also serves as a reservoir by reason of its elasticity, enabling us to take meals, instead of having to put in minute quantities of food frequently.

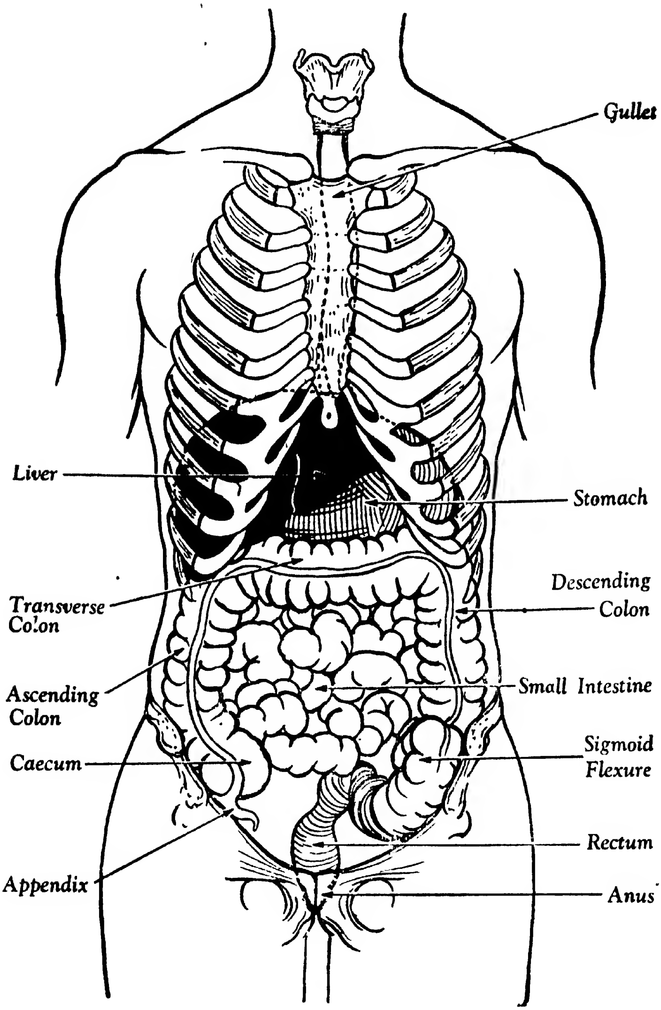
The task of absorbing food-stuffs into the tissues of the body belongs to the intestine, farther on, but a few things are actually absorbed direct through the stomach wall. These are things which need no digestion, such as water, alcohol, the simpler sugars like grape-sugar (glucose) and some salts.

Entry of Food Into Intestine

As the food passes around inside the stomach it must from time to time pass a small, dark door over which there is, so to speak, a notice saying "no admission." Then a collection of food particles suddenly finds the door open and slips through, and at once the door closes again. This opening from the stomach into the intestine is called the pylorus, and what causes it to open nobody quite knows. Certainly not because the stomach muscles push it from above; radiologists have seen it open many times when there was no wave of muscular contraction.

Some people have suggested that it opens when the food is ready to pass on, that is, when it is all smoothly dissolved and well mixed with acid, so that pepsin can have had opportunity to do its work, but this theory too has been disproved. Certainly it does not open to a clock, for the food it lets through may have been in the stomach anything from half an hour to six or eight hours.

An ordinary meal is allowed through in about three or four hours, so if the stomach is to be



LATER STAGES OF DIGESTION

Food passes from the stomach into the small intestine, where it is further broken up by the intestinal juices, the residue passing into the large intestine, which consists of the caecum, ascending, transverse, and descending colons.

allowed a little time to rest, meals ought not to be too frequent. If the meal is fatty, digestion is delayed, as has been explained, and therefore the progress is delayed.

As soon as the food-stuff leaves the stomach and enters the upper part of the small intestine it is set upon by a posse of housebreakers, all of which act at the same time. They come from three main firms: Pancreas, Liver and Gut.

Juice of the Pancreas

The pancreas of the calf is often served as sweetbread; it is a large gland (or factory-organ) lying across the back of the abdomen just below the diaphragm. It manufactures a juice which is delivered by a special pipe-line into the intestine a few inches below the stomach. This juice is still very watery, but rather less so than the earlier ones. It contains four breakers, or enzymes, one for protein, one for starch, one for fat and one for milk. Nature thus makes quite sure that everything gets attacked.

These enzymes again reverse their predecessor's taste in conditions, and demand an alkaline environment for their work. The juice is therefore made alkaline, and this is done by including in it some mineral salts called alkaline phosphates. It is alkaline enough to neutralize all the acid which comes through from the stomach.

Manufacture of this juice starts about a minute after the first morsel reaches the mouth, and production is stepped up considerably as soon as the material begins to enter the intestine; the presence of acid there acts as a kind of warning that the alkaline juice is needed at once.

The protein-splitting enzyme (trypsin) goes on where pepsin leaves off, and breaks off more lumps from the big molecules. It works more quickly than pepsin and also gets at some special proteins which pepsin finds too tough.

The starch-splitting enzyme (amylase) acts much more strongly than saliva on all kinds of starch, and breaks them all down to a complex sugar. This enzyme is not present in the juice of tiny babies, and that is why they should not be fed on starchy foods too young.

The fat-splitting enzyme (lipase) attacks the fats, which have hitherto escaped attention, save for being warmed up to an oily consistency, and breaks them into halves. One half is a fatty acid, and since acids are not popular in this part of the tract, they unite with the alkaline salts in the juice, and the substance so formed is a kind of soap.

How "Soap" Separates Fats

Soap may be unwelcome in the mouth, but it is being formed all the time lower down. Here soap is useful; it forms fatty soap-bubbles by making a film round spheres of fat, as soap makes a film round air when children blow bubbles. This prevents the fats from running together and forming an oily streak. It is important that they

should be kept separate and small, as they have later to be passed through some very narrow doors.

The presence of the milk-clotting enzyme in the pancreatic juice is something of a mystery, because all the milk that reaches it has always been junketed in the stomach.

Manufacture of Bile

The firm Liver produces the fluid called bile, which is stored in the gall-bladder, and run into the intestine by special pipe-line just beside the pancreatic opening.

It helps the action of the pancreatic juice, especially the fat-splitting action, partly by breaking up the fat so that it is easier to get at, and partly by maintaining the alkaline conditions required, by means of its alkaline salts. A great deal more bile is poured into the intestine after a fatty meal than after any other kind of food. Bile has, however, other activities in the body's economy and only helps digestion as a sideshow.

The juice produced by the lining of the small intestine is alkaline. It contains four enzymes and also a curious special enzyme which does not do any splitting itself, but which encourages the trypsin to do its work. Trypsin, the best protein-splitter we have, is sent out by the pancreas unfit for protein-splitting, and has to come into contact with this enzyme in the intestinal juice before it can begin.

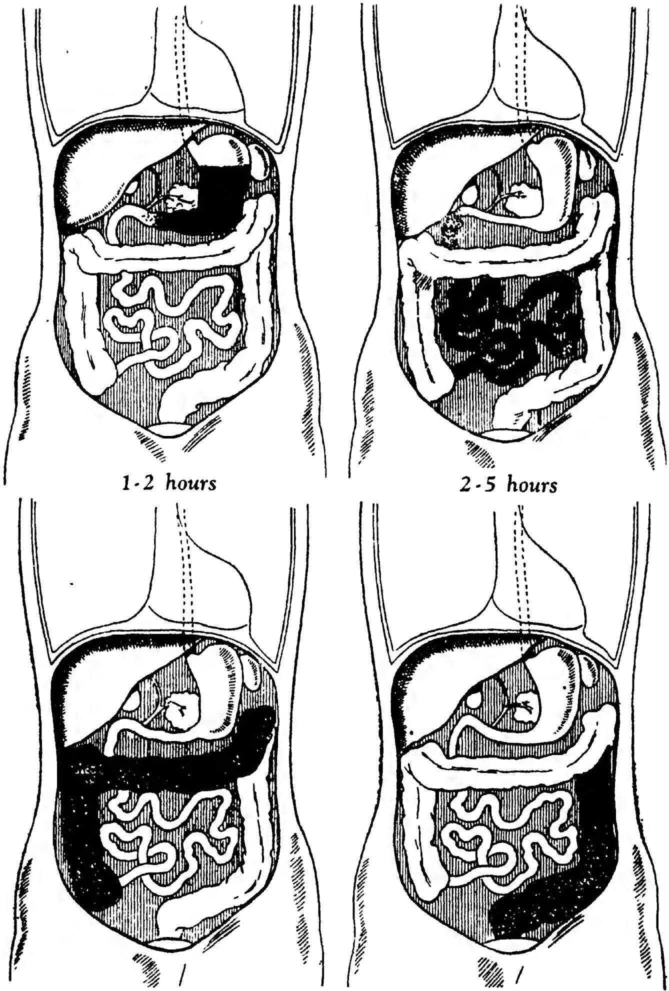
The four enzymes of the intestinal juice are maltase, invertase, lactase, and erepsin. Erepsin takes on where pepsin and trypsin leave off, ensuring that no molecule of protein origin is left larger than an amino-acid, which is the simplest product of protein formed by the breaking-up processes. It can now slip through the small doors it must pass on its journey.

The other three are sugar-splitting enzymes, very particular in their work, for each of them will act on one complex sugar, and on nothing else: maltase on the sugar maltose, invertase on invert sugar (most of the sugar in the basin is invert sugar) and lactase on lactose (milk sugar); when they have finished, all the sugars that have come into the body, in starch or complex-sugar form, have been broken down to the simple grape-sugar type, which is the only kind the cells will accept.

Absorption of Food into Cells

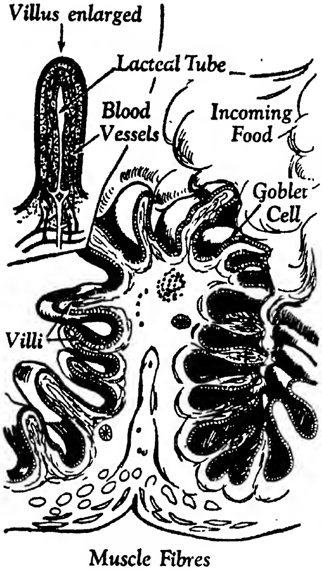
Strange as the idea may seem, none of this meal of Miss T's has yet really entered into Miss T. The alimentary canal is just a tube running through the body, as a corridor runs through a house from the front door to the back, but the visitor is not truly "in" the house until he enters one of the rooms.

This process might be compared with the experiences of some workman who presents himself at a royal palace. He arrives at the gate of the courtyard in his working clothes, grimy and unkempt. The guards at once seize him, search him for weapons, and give him a preliminary wash and brush-up in



PROGRESS OF FOOD THROUGH THE DIGESTIVE ORGANS

These diagrams show the number of hours taken in the various stages of digestion of a meal during its progress through the digestive organs.



PART OF SMALL INTESTINE
The small intestine is lined with the hair-like villi, which contain lacteal tubes and blood-vessels (seen in enlarged villus). Through these food particles are absorbed, fats into the lacteal tubes and proteins and carbohydrates into the blood.

the guard-house. If they dislike him, they may throw him back into the street, but if he passes their scrutiny he is allowed to walk across the courtyard (down the gullet) to the waiting-room just inside the palace building.

Here he is delayed for two or three hours while palace servants tidy him up still further. They may find him unsatisfactory and throw him back across the courtyard (vomiting), but if he is allowed past the waiting-room, he then passes through endless corridors (a dozen feet of the small intestine). As soon as he leaves the waiting-room he is pounced on by the royal personal staff; they have no longer the power to throw him out, but they mill around him, accompanying him along the corridors, washing and brushing and dressing him, until he is fit for the royal presence.

River-systems of Body

Then he passes the final scrutiny of the personal bodyguard, standing in a row beside the doors that open into the royal apartments. (These are the cells of the lower part of the absorptive intestine.) At last, he squeezes through a little aperture in the wall of the corridor and is really "inside." In terms of the food-particle, it passes through the intestinal wall into one of the river-systems of the body which will bear it to the organs.

Four classes of person have special passes which exempt them. They show their pass to the guard at the courtyard, go right on, and slip into the royal presence through a door in the waiting-room wall. These are water, alcohol, simple sugar and common salt (with one or two of its cousins, simple mineral salts).

There are two kinds of door—though millions of doors in all—one kind opening into the blood stream, the other into a channel called the lacteal, or milky, duct. Simplified sugars and amino-acids

(simplified proteins) enter the tiny twigs of veins and then run with the blood to the liver; fats go through the lacteal collecting duct to the root of the neck, where it empties into a big vein.

The lacteal system is simply a liver by-pass; fats go direct into the blood stream, and are carried to the skin to be deposited in the "coal-cellars" represented by the deposits of fat under the skin. Sugars may be passed straight on to the blood again by the liver, if they are wanted at once for fuel, but if not, the "coal-cellar" for sugar is the liver itself.

The two halves into which the fat was so carefully split in the intestine join together again as soon as they have passed through the little apertures in the intestinal wall, and so "fat" is formed again. Now it is human fat—not mutton or beef or pig fat. Because of this fat inside them, the lacteal pipes look milky, and so get their name.

Residue of Food

When all the successful applicants have been slipped through the doors of the royal apartments, there remains still quite a host of persons who passed the guards and servants who had the power to throw them out, but still did not pass the personal staff in the corridors of the palace. In other words, there is much residue, often called "bulk and roughage."

This is not all a mistake; the human intestine is so constituted that it works better if it has a good solid mass to deal with, and so some quite useless food is properly included in all diets: material like bran and husks from grain, and the cellulose covering of vegetable leaves.

Then there is always some material which might have got digested if there had been more time, but has escaped the house-breakers because of its specially tough walls. The contents of the lower part of the small intestine include muscle fibres (from tough meat), starch, cellulose and woody fibres, also some salts and soaps.

Bile Pigments

Here comes in another important function of the bile. Among its constituents are some coloured substances called bile pigments. These are manufactured in the liver from the waste of red cells. The red cells of the blood are coloured by an iron-containing substance (see page 84) and there is bound to be a certain small amount of worn-out iron compound at all times, part of which must be got rid of, since it cannot be put to any further purpose.

This "throw-out" or excretory function is performed by the bile. It is the bile pigments that give the motions their brown colour. If the liver is so disordered that no bile enters the intestine, the motions may be as colourless as clay.

What is to be done with all this waste? Nature deals with decaying matter by setting myriads of bacteria to work on it. The reptiles,

birds and mammals have taken the bacteria inside themselves for this purpose, and provided these "slave workers" with a special long wide corridor in which to do their work on the food waste as it very, very slowly passes down, like material on a moving belt in a factory.

In the small intestine all is busyness and quick movement; in the large intestine there is the atmosphere of a stagnant canal. Things are not stagnant, however (in health), for from time to time there is a tremendous heave, and everything moves along a foot or two; then the stillness settles down again.

Bacteria of Large Intestine

But the bacteria are not asleep; invisible save to very powerful microscopes, they are working with feverish activity, eating up the debris and changing its composition. Incidentally, they produce some gases, and these may become excessive and cause flatulence, and give the motions a smell which most people regard as unpleasant.

Occasionally the worker-bacteria rebel, or other bacteria, not such useful workers, creep in at the same time. These, if they get "inside," cause disease. The large intestine has had to deal with the problem by a vigilant police system all down its length. This is found in the form of many white blood cells (see page 86) and of a great number of lymphatic glands (police stations).

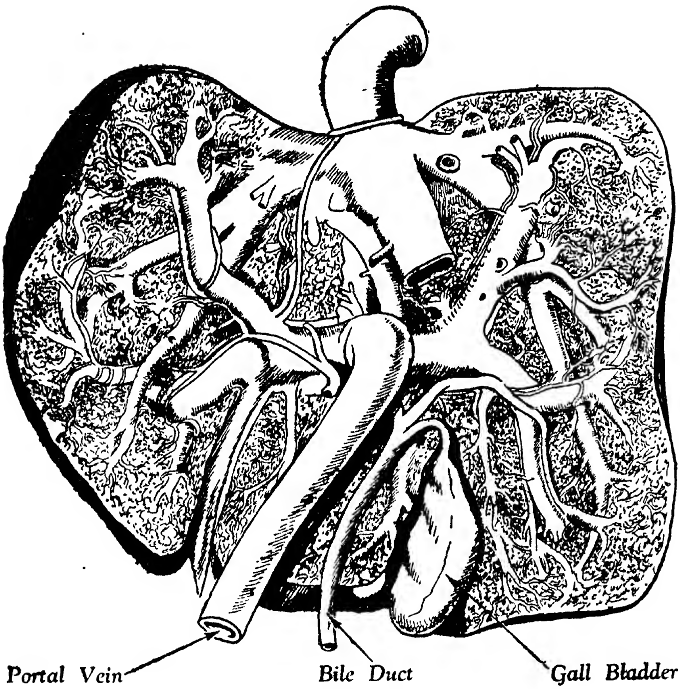
The lining of the large intestine is thin, flat and cautious—very different from the red, spongy, folded, inviting lining of the small intestine, which is eager to absorb anything which will pass its barriers. The large intestine is more concerned to keep things out.

Nevertheless, it does let a few things through. The water which has been poured out with all the digestive juices is too precious to be wasted, and most of it is taken back again, through the wall of the colon, into the blood-vessels. That is why the motions are firm and semi-solid although the food debris from which they are made was quite liquid. Moreover, when the bacteria set to work on vegetable masses in the debris, they break up cellulose walls and release sugars; these, too, are allowed to pass the barrier into the blood.

The nature of the food eaten by the various animals determines the length of the large intestine. The larger the cellulose content the longer the large intestine, until it reaches a maximum in the relatively enormous colon of grass-eating (herbivorous) animals. Man's colon stands about halfway between that of carnivores (flesh-eating animals) and that of herbivores, though rather nearer the carnivores. Myriads of the bacteria are passed out with every motion, but owing to rapid breeding no shortage occurs.

Work of the Liver

Let us now return to the liver and consider its work in detail. This organ is the largest and most important factory, storehouse and distributing centre in the body. It



VESSELS OF THE LIVER

This sectional view of the liver shows the blood and bile vessels. The portal vein brings all the food particles from the digestive organs for storage and distribution. Bile is manufactured in the liver and stored in the gall-bladder.

is a mass of dark red fleshy substance lying under the lower right ribs. In the middle of its under side, near the lower border, lies a small dark green bag, which is the place where the bile is stored until it is wanted in the intestine.

Naturally, the liver's relationship with the postal service of the body, the circulation, is very important, and it is always full of blood, coming and going. A large blood-vessel enters it from below, bringing all the deliveries of amino-acids and sugars from the small intestine, and such other small contributions as the large intestine makes to the supply.

This vein breaks up so as to send a branch right through the centre

of each of the many thousands of rounded workshops of which the liver is composed. These microscopic divisions are rather like the compartments in a honeycomb, roughly circular, but pushed a little out of shape by the crowding of many of them together.

Working Cells of the Liver

Around the central blood-vessel are packed the working cells of the liver, which pick off the substances they need as the vein sails them by. At the circumference of the workshop, all round the outside, runs another blood-vessel, which collects the blood after it has passed by the cell workers, and conveys it to the heart.

Alongside the circumferential vessel runs a bile vessel, which collects the bile manufactured by the cell workers and carries it to the gall-bladder.

Here is a list of jobs continually being done in the liver:—

1. Manufacture of bile.
2. Maintenance of a reserve store of sugar fuel, with immediate dispatch to any centre requiring it.
3. Storage of vitamins A and D.
4. Storage of amino-acids and dispatch of waste ones to kidney in suitably harmless form.
5. Preparing fats for furnaces.
6. Rendering poisons harmless.
7. Destroying worn-out red blood cells anddisposing of the debris.
8. Preventing anaemia.
9. Keeping up the heating system of the body.

In addition to all this, the liver before birth manufactures red blood cells, but during early childhood this job is taken over by the bone marrow.

We have seen how bile is poured into the small intestine when it learns that a meal has reached that level; and how it plays a small and secondary part in digestion. Although most of the pigment of the bile passes out through the colon, giving colour to the motions, much the greater part of the bile is taken back again to the liver with the food-stuffs, and thus does its work over and over again.

Importance of Bile

There is a certain amount of mystery still about the work done by this continually circulating part of the bile. Certainly, life and health cannot be maintained in the absence of bile, though it is easy to live without that warehouse called the gall-bladder. It is thought that some of the constituents of bile have something to do with resistance to infection and those other rather mysterious food factors, the vitamins, some of which are stored in the liver. We learnt earlier in the chapter that the liver is also the storehouse for sugar (see page 121).

As we have seen, the only way of making good wear and tear in the body is by using the amino-acids of the food. The liver is, therefore, a very important repair centre, whence amino-acids are dispatched to tissues which indent for them. The liver stores a few of these spare

parts, but not very many, and therefore there must be a constant flow of them through the food.

Unfortunately only quite a few are of the right kind; it is as if the body were calling, say, for ball-taps, electric-light pendants and gas-pipes, and had to take what it could get from a mixed collection of plumbers', electricians' and gas-fitters' supplies. Therefore a relatively enormous quantity of the amino-acids delivered to the liver from the intestine is so much waste for direct repairs.

The liver has, however, devised a way of making use of at least a part of them. It has discovered that if the nitrogen atoms are removed from the molecules, the rest can be used as fuel. So it sets a number of its hands to work on splitting off the nitrogen, throwing that aside into the blood stream to be dispatched to the kidneys in the form of a substance called urea (which the workers make by "marrying" the nitrogen to some hydrogen and carbon and oxygen) and then stacking the rest as logs for the great furnaces of the muscular system to burn.

How Fat Is Used as Fuel

Now it is another curious thing that, although the fats do not go through the liver with the rest of the food in the first place, they still have to pass through the liver workshops before they are ready for burning. They go straight to the fat depots, and then when they are wanted as fuel they are brought round to the liver again by the blood in order to have their molecules chopped smaller, so that they burn more readily.

When the body is being starved, so that the fat from under the skin is being used up as fuel, then the liver workers in this department do overtime, and sometimes the fat comes in faster than they can deal with it, and clogs up the liver. Thus an emaciated corpse may have what is called a "fatty liver."

Poisons and Worn-out Blood Cells

When the proteins are being broken down in the intestine some rather poisonous by-products are produced, and these may slip past the guards of the intestinal lining and reach the liver. There is a special police-system waiting for them if they do, and they are quickly thrown back into the blood stream.

The wear and tear on the red blood cells is very great; many of them get worn out every week, and the liver and the spleen both pick out the useless ones from the blood stream as it passes through them, conserve anything that can be used again, and put out the debris. One of the things always kept back is the iron atom; iron is very precious and is used over and over again to make the blood pigment.

Not long ago, doctors found that the disease called pernicious anaemia can be cured by making the patients eat liver and this led to the discovery that both the liver and the stomach manufacture a substance which prevents this disease.

The liver is by no means an important source of heat to the body, but wherever much work is done heat is produced, and the activity of the liver is such that the blood leaving it is about a degree hotter than the blood coming to it.

The use of food-stuffs by the various cells of all the organs of the body, to maintain their individual lives and perform their individual jobs—the economic balance-sheet of the body—is called metabolism. On the other side of the ledger from the intake-processes we have been discussing are found, on the one hand, the profits (the work done by brain and hand and muscle and gland) and, on the other hand, the losses (the excretions).

For, however careful the economy, there must be waste: partly the rejection of useless material, partly "trimmings," and partly the dead bodies of cells which have lived their span, or had the misfortune to be killed by some poison or accident.

Exit Doors for Waste Products

There are five exit doors from the body by which waste products are returned to the outside world. These are the bile, the skin, the lungs, the bowel and the urine.

The bowel conveys to the outside the waste turned out by the liver into the bile in the form of bile pigments, though a certain amount of these also find their way out through the kidney, and give the colour to the urine. The bowel also removes from the body proper, as distinct from the waste of food which has been rejected by the intestinal cells, a small amount of mineral salts such as calcium and phosphorus.

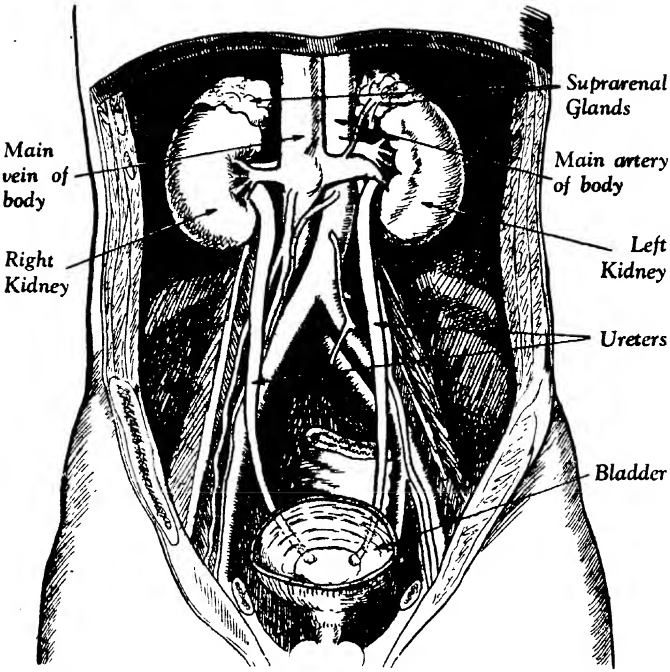
Through the lungs, water and carbon dioxide are always being removed; and abnormally the lungs will also throw out alcohol (as every policeman knows: "His breath smelled strongly when arrested") and acetone, the queer, heavy, sweet smell of which is sometimes noticed in the breath of children who are bilious.

Loss of Sweat Through Skin

The skin produces sweat, which gets rid of a pint or two of water a day, even when there is no perspiration in the ordinary sense of the word (see page 75). Much more water may be lost when the sweat really rolls off the body. And with the water go a few salts and traces of urea.

In addition to sweat, the skin produces an oily substance, to keep the surface supple and protect it. This also forms a small exit door for waste.

Far and away the most important of all the "Ways Out" are the two kidneys, lying at the back of the abdomen, in the upper part of the loin, against the lowest ribs. These doors are guarded by some of the most highly trained and intelligent workers in the body: cells which know to the minutest fraction how much of everything the body has, and how much it can afford to let go. The fact that the composition



FUNCTIONS OF THE KIDNEYS

The kidneys perform duties very important to the body's economy. They are responsible for maintaining the balance of salts and fluid in the body. Thus it is they who decide how much of the various salts must be returned to the blood stream and how much urine may leave the body. Urine leaves the kidneys by the ureters and is stored in the bladder until voided.

of the body remains the same, despite constant changes of intake and circumstance, is largely due to the careful work of the kidney.

The kidney looks a fairly solid organ on the breakfast plate, but seen under the microscope it appears as masses of tiny, coiled, closely packed tubes.

As these tubes, or tubules, wind on and on, through the substance of the kidney, doubling on themselves, so that any one tubule is many times the length of the whole organ, they begin to run together, forming larger tubes, and finally they all run into large river mouths, which form the tough smooth part

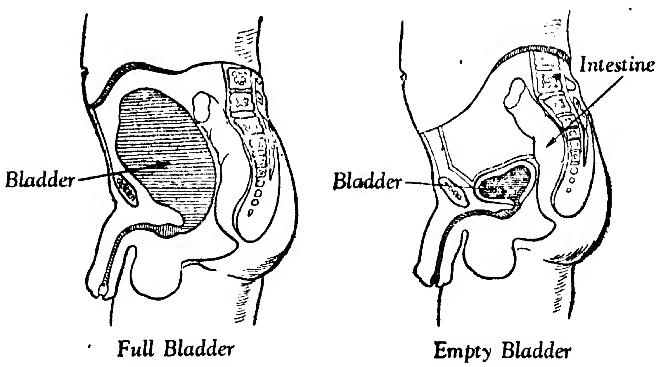
of the kidney leading to the ureter.

This tube, about the size of a goose-quill, runs down the back of the body to reach the bladder, which lies in front of the abdomen at the bottom. Here the urine can be stored, as bile is stored in the gall-bladder, until a convenient time for voiding it. This is only a convenience; no further changes take place in the urine after it has left the kidney.

The blood entering the kidney is first conducted to a number of small workshops shaped like tufts; the kidney workers here are not highly skilled and do no more than offer a certain amount of resistance to the pressure of the jostling fluid and solid contents of the blood. They will not allow any blood cells to pass them; they keep their turnstiles too small for that. But they will let anything in solution go by, and the amount of fluid and dissolved contents that passes them depends entirely on the pressure.

Thus, in technical terms, the formation of urine ceases when the blood pressure falls below a certain figure. This is the most primitive kind of excretory system and was good enough for lowly animals who lived in the water.

As soon as life began on land, however, something more had to be done, because these stupid porters would let out all the precious water and salts, which could no longer be renewed at any time as in the days of sea life. So behind them were set the intelligent, selective cell-workers of the lower parts of the tubules who care nothing for pressure but are only concerned with the body's needs,



RESERVOIR FOR FLUID WASTE

The bladder acts merely as a reservoir for urine, since there are no changes in its composition after leaving the kidney. The urine is carried drop by drop by the ureters into the bladder, which becomes distended, as in the diagram on the left. Then the bladder is emptied and becomes small again.

about which they have what seems almost a miraculous knowledge.

The blood runs closely alongside each little tube, as passengers file along the counter at a customs-house, and "declares" its luggage: so much urea, so much sugar, so much salt, and so on. The kidney cells, like efficient customs officers, promptly pounce on certain substances as contraband—much too precious to leave the body—and remove them, throwing them back into the blood stream.

Waste Products of Blood Fluid

The fluid coming to them from the first check is all the fluid part of the blood, and contains all the things normally found in blood. Some of these are pure waste: for example, urea, which was manufactured in the liver specially to be thrown out as soon as it got to the kidney. Another example is creatinine, which is the form in which muscle cells bundle up their rubbish for the kidney's attention. Such substances the tubules allow to flow past them toward the ureter.

But when they find some sugar passing them they at once cry: "Hi, stop: this is useful to the body; it must not be allowed out," and they promptly seize it and throw it back into the blood stream, so that it gets back into circulation by the vein leaving the kidney.

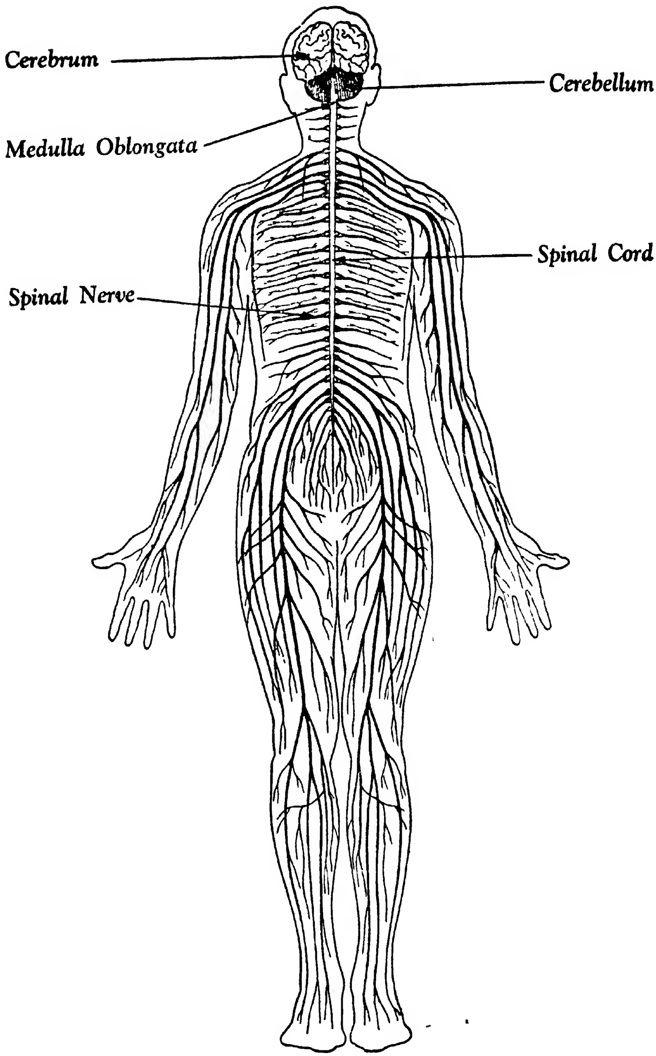
Just occasionally they let some sugar through; their intelligence service may have reported that the blood was dangerously loaded with sugar because somebody had been eating too many sweets. This, however, is not very common and only happens just after the meal. If the cells let sugar through regularly and continuously there is something very wrong with the economy of the body.

Then the kidney has to attend to the salt-content of the blood. The amount of various salts in solution in the blood stream has an important influence on many delicate life processes, such as the action of nerves, and must be kept quite constant. The kidney cells throw back into the blood just as much of each salt as the blood needs at a particular moment.

Balance of Salts and Fluids

They act in the same way with the water, keeping the total volume of the blood at the right figure. If there is water shortage in the diet, the urine becomes scanty; if much is drunk, then much is let through by the kidney. Another important factor is the degree of acidity or alkalinity of the blood, which is determined by the amounts of certain salts dissolved in it; the kidney carefully selects for removal those salts which are disturbing the acid-alkaline balance at any given moment.

Thus, the amount and composition of the urine is constantly varying and a great deal can be learned about the body's economy from studying it, and from seeing how the kidney behaves when it is set certain special problems to solve.



CENTRAL NERVOUS SYSTEM

Nerve cables branch off from the spinal cord to all parts of the body

CHAPTER SIX

THE NERVOUS SYSTEM

Simple form of nervous system. Composition of nerve cells and fibres. How a reflex arc is formed. Development of the brain. Structure of brain and spinal cord. Central nervous system. Characteristics of reflex action. Sympathetic and parasympathetic nerves. Internal and external receptors of messages. The five special senses: touch, taste, smell, sight, and hearing.

IT has been calculated that there are twelve thousand million nerve cells in the human body and that if all the nerve fibres of the human nervous system were tied together they would go fifty times round the equator.

As might be expected, this system is an extremely complicated one. Knowledge of the way in which it has been built up through the various simple animals is a great help towards understanding it in its most complex form.

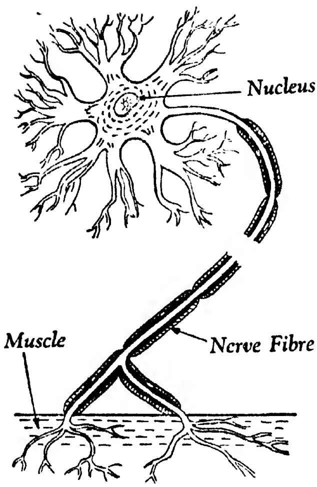
The uni-cellular organism, like the amoeba, has no nervous system, but it manifests behaviour characteristic of a nervous system: that is, it is aware of changes in its environment (this is called sensory activity), and it responds to these changes (this is called motor activity or movement).

As the multi-cellular organisms become more complex they set aside special cells for the government of these activities. The impact of the environment on the organism is perceived thereafter not by every cell on the outside of the body but only by special cells which are called receptors. These are specially developed to be sensitive to changes around them. The response to environment is also given over to special cells which bring about movement and are called effectors.

Since, in simple animals, all movement is a response to some external change, there must obviously be a link between receptor and effector in order to start the response. This link is called the communicating cell, or nerve cell, and the three cells are kept in touch by long thin fibres which meet like the fingertips when the hands are lightly brought together.

Roughly speaking, this simplest form of nervous system is very like a penny-in-the-slot machine. The change in the environment is the penny; it impinges on the receptor, the slot, and in some way passes down to the centre of the machine, where, by a mysterious process, it is converted into chocolate or cigarettes; it emerges again at the effector, or delivery tray, as a movement or a secretion.

These nerve cells, whose duty it is to form the middle units in a chain stretching from the sensitive to the active cells, are arranged



NERVE CELL AND FIBRE
Nerve cells are of a roughly star-shaped pattern, with a central nucleus. Each communicates with other cells by a slender fibre, which may be several feet long. The nerve cords consist of many thousands of nerve cells (or neurones) and fibres.

geographically in whatever manner is most convenient. For example, in an umbrella-shaped organism like the jellyfish they are placed in a ring round the umbrella.

A lot of invertebrates and all the vertebrates (including, of course, man) are built on the principle of being longer than they are broad and having two symmetrical halves on either side of the middle line. In such a plan it is obviously most convenient to have the nerve cells in a long strip running the length of the body in the middle.

Since the ground plan also includes the division of the long body into a number of segments—as seen, for example, in worms—the ground plan of the nervous system is like a string of beads, with a collection of the nerve cells in the middle of each segment, and connecting strings between.

Head End of Nervous System

Another general principle of structure then came into being, called the head end, a principle well illustrated by our own nervous system. One end of the long thin animal always goes first, and the other end always follows. Obviously the head end is much the more important from the point of view of the nervous system, because changes in the environment as the animal proceeds will all impinge first on the head end; therefore, the collection of nerve cells in the front segment becomes very much larger than in all the others. Even though man does not proceed on all fours, the head end remains the more important.

In all vertebrates (again including man) the nerve strip is not a solid cord but a hollow tube, which consists of many thousands of nerve cells or neurones, the anatomical units of the nervous system. These cells are characterized by an irregular star-shaped pattern, the points of the stars being drawn out into slender processes or fibres.

These processes extend the capacity of the cell for contact, as they

make connexion with other nerve cells in various ways: for example, by twisting round them or their processes, or just touching. There is, however, always a slight gap between the processes of one nerve cell and those of another, and this gap is called a synapse.

There is one-way traffic along the processes and across the synapses, and those processes which bring messages into the cell are called dendrites, or afferent fibres, while those which take messages out are called axons, or efferent fibres. The processes may become very long indeed, and even if they wander far away from the cell and appear to the dissector to be entities, and are spoken of as nerves, they are still, nevertheless, only processes of a distant nerve cell.

Length of Nerve Fibres

The actual cells of the central nervous system are all found in, or very close to, the central tube, but some of them have processes which extend great distances: for example, from the small of the back to the tip of the toe. The processes remain entirely dependent for their life on the nucleus of the cell, and if the nucleus dies the whole cell and all its processes are bound to die also.

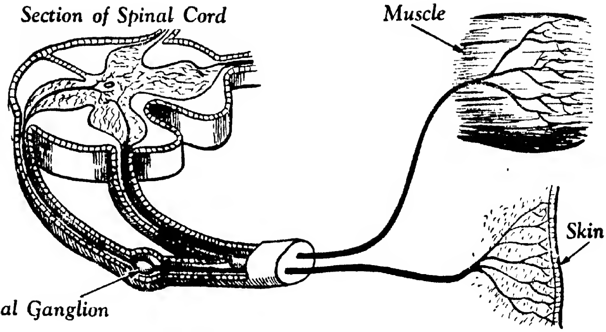
If, however, the nerve is cut across, the part which is cut off from the cell will die, but the upper end, still in contact with the cell, will live, and will in time try to grow out again along its old path, provided that the path can be kept open for it. The trouble with most wounds of nerves is that masses of scar tissue, which grows very quickly, form before the slower nerve grows down again, and the delicate nerve processes fail to penetrate the obstacle.

The nerve processes are solid fibres; they run in bundles, or cables, many hundreds in the smallest visible nerve, and are carefully packed in fatty protective wrappings which make the whole nerve look yellowish to the eye. The packing tissue in the central nervous system is more delicate and contains no fat; it is called neuroglia.

The whole nervous system consists of cells and cell processes packed in neuroglia and fatty fibrous tissue. The cavity of the tube contains a straw-coloured fluid which nourishes and drains its inner layers (cerebro-spinal fluid). Blood-vessels run along the outside and penetrate a little way into the substance, taking nourishment to and draining the outer layers.

Disorders of Nerves

It is obvious that the use of the term "nerves" for symptoms of mental ill-health or disorders of conduct is an entirely wrong one. Those disorders have nothing whatever to do with the nerves as the anatomist knows them, the diseases of which are an entirely different branch of medicine: neurology. Their symptoms consist mostly of paralyses of various kinds (due to damage to efferent or movement nerves), spasms of all kinds (due to



HOW REFLEX ACTION TAKES PLACE

Reflex action is the simplest form of nervous activity in the body, and the will plays no part in it. Messages from the receptors in the skin do not travel up to the brain, as they do when voluntary action is concerned, but only to the nerves situated at the back of the spinal cord. From there they come back to the particular muscle which is to effect the action.

abnormal stimulation), and abnormal sensations or losses of sensation due to interference with the afferent (sensory) nerves.

The neurologist also deals with diseases (tumours, interference with blood supply, and so on) of the central nervous system tissues, but even these rarely produce the symptoms that patients like to call "nerves."

As the neurone is the anatomical unit of the nervous system, so the physiological or working unit is the reflex arc. The neurones are the bricks of which the nervous system is built and to which it can be reduced by suitable dissection, but if anything at all happens in the nervous system, a complete reflex arc is always involved. One neurone does not act alone. The simplest possible reflex arc consists of:

1. A receptor.
2. An afferent neurone—i.e. a nerve cell and processes carrying one-way traffic from the receptor to the centre.
3. A synapse.
4. A central neurone—i.e. a nerve cell and processes not communicating directly either with receptor or effector.
5. Another synapse.
6. An efferent neurone—i.e. a nerve cell and processes in which traffic moves from the centre back to the periphery.
7. An effector—muscle or gland.

The action taking place through this unit is called reflex action, and is little more than the working of the penny-in-the-slot machine which has already been described.

Some kind of a change in the environment impinges on the receptor and the receptor responds by sending a message travelling up the nerve fibre to which it is attached. The nerve cell of that fibre sends a message across the synapse to the central cell. This passes the message on to the efferent cell, which in turn sends it down its fibre to the effector connected with it, which then makes the response.

The method by which the impulse travels is not completely understood. In the nerve fibre it appears to be some kind of electro-chemical activity, which proceeds by small jumps, as if a row of bricks standing on their ends were so placed that each brick in falling knocked down the one next to it, and so on, up the length of the nerve fibre. When the bricks have been knocked down, it takes a little time to set them up again, and so a slight interval has to elapse before another message can pass along that particular fibre.

Crossing the Gap Between Nerves

Across the synapse the process seems to be a chemical one: the end of the nerve fibre secretes a chemical substance which floods the little gap and stimulates the fibre at the other side of it.

What we have described so far is a simple basic pattern, but from this we can build up a more complete picture of our own nervous system.

Some slot machines have two or three different kinds of slot, into which may be placed, not only pennies, but also sixpences and shillings, and to their delivery trays come not only chocolates and cigarettes, but also bottles of scent, handkerchiefs, a portrait of your future husband, or your horoscope.

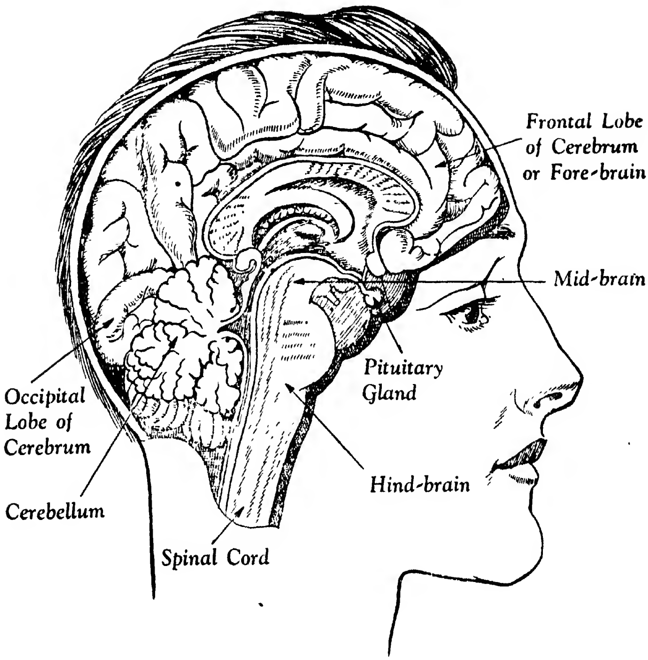
Types of Reflex Action

On well-equipped piers the penny in the slot may produce a vivid mime of the execution of a condemned criminal, or a cinematograph picture of what the butler saw in Paris.

In another type of machine the penny dropped through the slot causes some pointers to revolve on a disk, and a portentous voice announces your weight, or a hand shoots out with a card indicating the figure recorded.

If, in imagination, all these varieties are translated into terms of the nervous system, and a few more complex ones added, it is clear that very complicated living reactions can be obtained without any advance on the reflex principle. The environmental stimulus may produce an internal change without any visible sign, or there may be visible response with, or without, an internal drama.

In such a nervous system it is clear that activity depends entirely on a change in the environment. Unless a receptor is stimulated, nothing at all will happen. In man, however, as in all animals, there is an internal environment as well as an external one; that is to say,



PARTS OF THE HUMAN BRAIN

The brain of man consists of: the fore-brain, or cerebrum, the seat of intelligence and memory; the mid-brain, which is a short thickened stem; and the hind-brain, which is really a continuation of the spinal cord. At the back is the cerebellum, or little brain, which is concerned with balance.

changes take place inside the body and there are sensory receptors in all the internal organs.

Thus, food in the digestive canal or a change in the blood stream may constitute what we have hitherto spoken of as a change in the environment. Much living reflex activity therefore may go on through the nervous system even if the outward scene remains placid.

It is important to realize to what a large extent we are limited by our receptors. Modern physical research has revealed what an enormous amount is going on around us of which we are not aware: ultra-violet and infra-red rays do not stimulate our eyes; radio waves cannot excite our ears. Of these we cannot be aware because we have no receptors which

can be "tuned in" to them.

In this kind of reflex nervous system the centre is purely a clearing station or sorting house for the messages coming in from the receptors, redirecting them to the proper effectors. It keeps no records at all. The next great step in the evolution of the nervous system is the establishment of a library or record room: this is called the pallium.

From the lowliest vertebrate to man there is not so very much difference in the long nerve tube, which in all vertebrates has three enlargements in front: the fore-, mid-, and hind-brains. The walls become thicker; the central canal becomes proportionately smaller (especially in the enlargements); more and more cables run to and fro and mass heavily near the front end; but that is all. If the pallium be removed, the central nervous system of man consists quite simply of a long nerve tube with three enlargements at the head end. The difference in the pallium, however, is so great as to overwhelm the underlying similarity of the rest.

How the Brain Evolved

The pallium appears in fishes as two little prolongations like rabbit ears growing out from the front of the primary fore-brain; these are called the secondary fore-brains. They are hollow and have thick floors and thin roofs, like the rest of the system.

In evolving from this simple form seen in fishes, they grow

forward and meet the front of the skull; they turn upward and reach the top of the skull; they turn backward and stretch to the back of the skull; and still they grow, finally turning forward again, to end, in man and the higher mammals, just beneath the ear.

All the time they are growing in all their dimensions, laying down millions of new cells, thickening the walls and floor so much that you would never believe they were tubular if you did not know; and even if you did know, you would have difficulty in finding the distorted chink which represents the original hollow central canal.

Storehouse for Experience

They grow so thick that they meet in the mid-line over the whole extent of the brain; they grow so enormous that to superficial inspection the brain of man consists of nothing else. All this tremendous development is the expression of one idea—the most brilliant in the history of evolution—the provision of a storehouse for experience.

The experiment was first tried with the receptors of smell in fishes. Smell in such creatures is far and away the most important sense: the fish smells out food, danger, and the suitability of its environment in every way. It shows the very beginnings of pallial development in the two little outgrowths from the fore-brain, and these were used as filing cabinets, or storage annexes, to the central nervous system, in relation to smell. Some

or all of the impulses coming in from the smell receptor and of the messages going out in response were put on record.

Evolution of Intelligence

This proved to be a most wonderful idea; it meant that the animal could remember and learn by experience. When a message came in from the smell receptor it was possible for the "filing clerk" in the pallium to compare it with previous similar messages, and to modify the response by the results of previous responses. The evolution of intelligence had begun.

The old slot-machine system of reflex action remained in being, but it was overshadowed, both anatomically and physiologically, by the new reference-library system, which had power to modify it.

When the smell pallium had been established for some time, the vertebrates had to experience a great upheaval in their life and environment, a very big step forward in the story of evolution. Indeed, the story of the evolution of the pallium is as wonderful as the story of evolution itself—and is no small part of it. By no means for the last time, living creatures were faced with a call to new adaptation; and, as always, some failed and died; some abandoned the struggle and regressed; and some made the changes demanded by evolutionary progress.

The challenge this time came from drought. The most progressive fishes had developed—in addition to a smell pallium—a stiff vertebral column and a tail, so that they could swim against currents instead of being wafted about at the mercy of the water. The adventurers had swum against currents up estuaries, into rivers, streams and inland pools—but they were still fish.

Then the pools and streams dried up. The regressive group hurried back to the sea and remained fishes. The others ventured into land life and became amphibia, and the forerunners of man.

Extension of Brain to Sight

Now smell is still very important on land, but when the environment is clear air instead of dim water, the eye becomes an even more useful sense organ. Having learnt the secret of pallial success with smell, these early land animals began at once to extend it to vision.

The result was a fearful bombardment with stimuli and need for rest. Smell particles do not continuously assault the nostrils and, even when they do, the receptor mechanism quickly tires and ceases to relay the messages to the brain. But the eye is assaulted every moment of light, and its receptors do not cease work. Hence the development of sleep—when as many stimuli as possible are cut off from the receptors.

A sight -pallium is first found among the higher reptiles, who succeeded the amphibia. Snakes have no eyelids, because their brains are not recording and filing

all the messages which fall on their eyes. Lizards, on the other hand, have eyelids, because their central nerve cells are actively taking in and filing many things of which a snake remains placidly unaware.

The birds, arising from the early reptiles, found a sight pallium so advantageous that they specialized in it and left no room in their brains for anything else. The mammals, destined for higher things still, started life not so much with a large pallium as with a small pallium which was not wholly divided between the two senses of smell and sight, but capable of dealing with new senses in due course.

The first little mammal must have been a very despised creature when he shot furtively in and out among colossal reptiles which were so clearly the lords of creation at that time. He survived their assaults because his higher body-temperature made it possible for him to react much more quickly with his nervous system than could the cold-blooded reptile. He could dash in and steal a dinosaur's egg and be a mile away before the dinosaur's slow reflex system could react in order to execute its revenge.

Effect of Tree Life

The next thing that happened on the way to man was that a very unimportant, small, unspecialized, shrew-like little mammal ran up a tree and began to live there—on fruit and nuts. It was fairly safe among the leaves, because the flesh-eaters had mostly become too heavy for the small branches, owing to the need for power in striking down their prey. Also, it was able to obtain its food without much difficulty, so the little mammal lived a life of relative ease.

Development of Mental Powers

For perhaps the first time in history it was possible to sit and think without jeopardizing life—from starvation or a predatory claw. The result was a tremendous development of brain, that is, of the pallium, or the power of memory, learning and reflection.

The little animal became so very much cleverer than its fellows which had stayed on the ground, wrestling with the difficulties of life down there, that when it once more came down from the tree to live on earth, it was able to defeat all its strong, swift enemies by cunning Thus man survived among the flesh-eaters which would have devoured him, because of his previous period of retirement in the tree-tops.

One of the things that happens when an animal lives among the branches of a tree and feeds on fruit is that it ceases to collect its food with its mouth and begins to use its hands. This then has two results: one is that there is no need for a long nose which can poke into things and catch hold of food, because the food is conveyed to the mouth by hands. The nose flattens so that the animal begins to see what lies in front with two eyes at once, instead of seeing on one

side of its nose with one eye and the other side with the other eye.

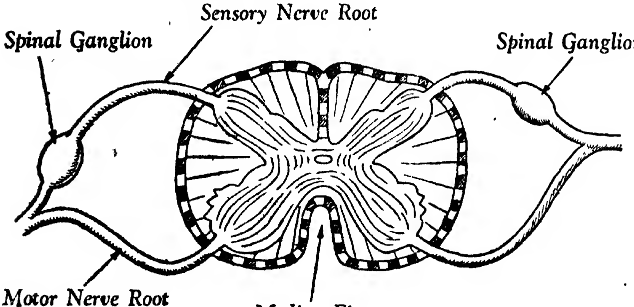
This two-eyed vision is called stereoscopic vision, and brings an immense stimulus to brain development. It means that the two eyes send to the brain two slightly different pictures, and the brain considers both simultaneously and learns to draw deductions from them in matters like size and distance of objects. People who have lived for a time with one eye only, know how impossible it is to judge sizes and distances without the aid of the second eye.

The second result of tree life is the immense development of the hand and fingers as delicate and precise sense organs and implements. This meant a corresponding increase in the pallium; more and more filing clerks to deal with the constantly increasing new information being sent in; and more and more movement managers to execute and co-ordinate the new fine movements of the upper limbs.

Thus the hands were used to explore the world and the creature's own body, so that it became more and more aware of the world around, and of itself. When it came down from the tree it had a nervous system that was very little different from our own.

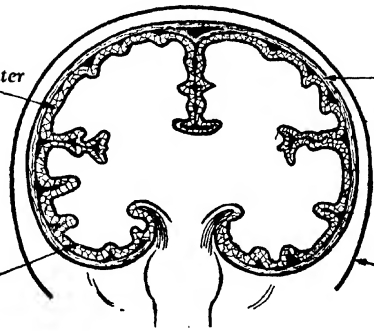
With this general picture before us we can consider the detail of our nervous system. The human nervous system consists of:—

1. A long column of nerve cells and fibres running down the spine, called the spinal cord;
2. A large collection of nerve cells and fibres—the brain;
3. Fibres which emerge from these centres and pass to and from all parts of the body—the nerves;



SECTION ACROSS SPINAL CORD

The spinal cord is composed of nerve cells (grey matter) surrounded by nerve fibres (white matter). There is a partition through the centre, which becomes a cleft in front (median fissure). Bundles of sensory and motor nerves come out from the back and front on both sides of the cord, joining outside to form a mixed nerve running to the part of the body they supply.



MEMBRANES OF THE BRAIN AND SPINAL CORD

The brain and spinal cord are protected by three membranes, known as maters or "mothers." The outer, or dura mater, is tough and thick; the middle, or arachnoid mater, carries a delicate tracery of small blood vessels; and the inner, or pia mater, wraps the brain and cord like a skin.

4. A separate system of cells and fibres dealing only with the unconscious vital processes of the body called the autonomic nervous system.

The spinal cord is a soft, whitish, marrow-like column with a central canal running down it, and with a mass of nerve cells in its centre and many stout cables, made of bundles of nerve fibres, running up and down its outer sides. It is protected first of all by the bodies of the vertebrae and then by three layers of packing, which also protect the brain and were called by the ancients "mothers."

The outer is the dura mater or "firm mother"—a tough, thick fibrous layer; inside this is the arachnoid mater or "spider-web-like mother," which gets its name from the delicate tracery of small blood-vessels which nourish the cord. The innermost layer of all is called the pia mater or "devoted mother," because it wraps the cord about closely in all its contours.

Between each two vertebrae, a large nerve bundle comes out of the front of the cord on each side, right and left, and another bundle goes into the back of the cord. Just outside the bony column these two bundles join, and run to that part of the body which they supply. This is called a mixed nerve, that is, a cable which contains both sensory and motor fibres.

The spinal cord shows two enlargements corresponding to the extra number of neurones needed to deal with the limbs. The lower enlargement is in the small of the back and is concerned with all the nerves of the legs; the upper

enlargement is at the root of the neck to deal with the arms.

Tracing the spinal cord upwards, it enters the skull by the large round hole at its base, and then becomes the hind-brain. This is not unlike the spinal cord in structure, but it is a little flattened out, and has a very thick floor to the central canal.

Parts of the Brain

The reason for this is that here lie the cells of the neurones dealing with the head and face. Here also are some of the most important centres of life: the centres which control digestion of food, breathing, blood pressure, heart-beat and so on. Without a hind-brain the human being cannot continue to live.

Over the roof of the canal is a lump like a small cauliflower, called the cerebellum. This is concerned with the delicate problems of poise and balance, and it has special connexions with the semicircular canals and labyrinths which lie by the inner ear. The cerebellum also enables man to make smooth, balanced and nicely-gauged muscular actions.

Proceeding forwards and upwards from the hind-brain, there is a short part called mid-brain, which also is like a thickened piece of spinal cord. It has a very thick floor, because the floor is composed of the immense cables containing the nerve fibres from all over the body passing up to the front of the brain. In its roof are some cells which deal with the movements of the eyes, and here sight is co-ordinated with eye movements so that we can follows things round with our eyes and look in any required direction.

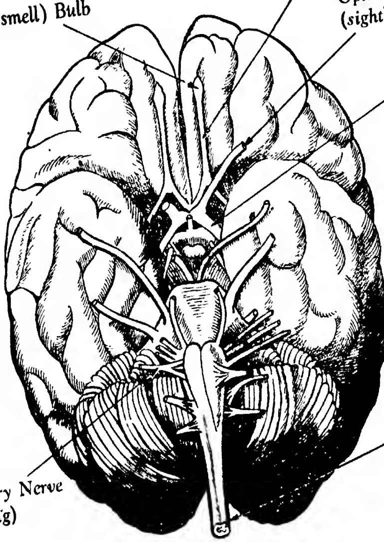
As soon as we pass forward to the fore-brain, we lose our sense of being in a tube, however thick its walls. All resemblance to the spinal cord is lost. From here has grown out the pallium or secondary fore-brain, with all the enormous complications involved in human intelligence. Down in the floor of this part is a very interesting and inadequately explored part of the brain, called the hypothalamus, which is closely linked with the emotions, the ductless glands, and the autonomic nervous system.

Centre of the Will

On either side open out the two enormous pallial outgrowths which have become relatively so big that they appear to constitute the whole brain when it is looked at without dissection. These are the cerebral hemispheres—the seat of mind and organ of thought, the home of consciousness and voluntary movement. They consist of a thin but very wrinkled mass of greyish tissue composed of nerve cells, the cortex or rind, inside which is white matter consisting of the millions of nerve fibres which run to and from those nerve cells. The puckering is simply an increase of cortex area in proportion to the amount of the skin surface from which messages may go in.

The cortex varies from two to four millimetres in thickness and

CENTRES OF THE BRAIN



NERVES OF THE BRAIN

The brain seen from underneath, showing the twelve pairs of nerves of the head, which include the nerves of sight, smell and hearing. The nerves cross over before entering the brain from the spinal cord, and this explains why the left side of the brain controls the right side of the body and vice versa.

is primarily a manager of muscle and seat of consciousness, its job being to increase the animal's grip on the world about it and to increase the influence of the world on the animal. It consists of four layers of cells, the innermost one of which is noticeably thinner in idiots. Otherwise, very little success has accompanied attempts to associate the structure, size or weight of the brain with varying degrees of intelligence. The largest brain known is that of the fin whale, but its intelligence is certainly not remarkable.

Intelligence is almost certainly a matter of good communications between the various neurones, rather than of any number or weight of nerve cells. The back part of this cortex is known to be associated with the sensation of sight and if it is destroyed a man

may be totally blind, although his eye and all his eye nerve paths are in perfect order. Round about it are the centres which have filed previous experiences through the eyes and associated them with experiences through the sense organs of touch, taste, smell and hearing.

At the side of the cortex, roughly the part that lies underneath the ears, is the centre for hearing, with a similar associative area round it. Still further forward, about the front of the hair line, is the centre for muscle movement in all parts of the body, and in front of this is what is called the silent area, because no one knows what it is for, and it draws no response to electrical stimulation.

Area Responsible for Speech

On one side only there is a little area which is responsible for the power of speech. All the other senses seem to be found on both sides, but this is found only on the left side of the brain in right-handed people ,and only on the right in left-handed people.

The cortex is also the centre for a spécial kind of reflex action which is called a conditioned reflex. This will be dealt with in the section on psychology (page 213), under which heading it properly belongs. In the meantime let us return to the simple reflex action.

As in the lower animals, the physiological or working unit of the human nervous system is a reflex arc; but the simple reflex arc described earlier, consisting of only three neurones—one going in from the outside to the centre: one going out from the centre to the outside: and a central one connecting them —is not often found in the human nervous system.

Reflex Action in Man

The simplest reflex action in man is enormously complicated by the necessity for co-ordinating the various activities. Nearly all the reflex arcs in the human body have a number of neurones interposed between the one coming in and the one going out again on the same arc. These interposed neurones serve to link up one reflex arc with several others—sometimes hundreds of others—so that movements are beautifully co-ordinated in all related parts of the body.

The neurones may be combined in such a way that the response to one reflex arc starts off a stimulus in another, thus building up what are called chain reflexes. Arcs may also be so combined that one stimulus from the environment can excite either or both of two responses; or two receptors on the outside may both excite the same response; or, more complicated still, stimulation of either of two receptors may produce either of two responses.

Reflex actions show certain characteristics, which are as follows:

Localization: it is necessary to apply a stimulus to a given region to produce a given result. For example, if anyone aims a blow at your eye, you will involuntarily and

reflexly shut down the eyelid to protect the eye. If anyone taps your knee in the right place your foot will give a kick—again involuntarily and reflexly. But, of course, a tap on your knee will not make you blink, nor will a blow aimed at your eye make you kick—at least, not reflexly!

Delay: the response is recorded appreciably after the stimulus, even though it may be a very quick one. The time is taken less in sending messages along the nerve fibres than in passing from one neurone to another. It may take as much as two-thousandths of a second for an impulse to bridge the gap (synapse) between the process of one nerve cell and the process of another.

Summation: this means that a very weak stimulus does not excite the receptor, and so no message is passed and there is no response, but sometimes, if such a weak stimulus is repeated over and over again, it seems to overcome the inner tension of the receptor, and a reflex response will be seen. After that, once the receptor has started recording it, the same weak impulse will provoke the same reflex response every time.

How Fatigue Affects Reflexes

Fatigue: a reflex arc can get tired and after a time ceases to respond to the stimulus. This tiredness is felt first in the synapse and then in the receptor. The nerves themselves seem never to get tired of passing messages, any more than the telephone wire does, though the girl who plugs in may show fatigue and cease work, and the person who makes the call may become too tired to lift the receiver.

Irreversibility: as mentioned earlier, there is only one-way traffic along reflex arcs, and no messages ever pass in the reverse direction. This again is due to the synapse; a nerve fibre when cut out and put on a laboratory bench will pass messages quite indifferently in either direction.

Resistance of Reflex Arcs

Resistance: normally, reflex arcs which adjoin each other show some resistance to taking up messages from each other. For example, there is an anatomical connexion between the reflex of the knee-jerk and the nerves which supply the muscles of the back, but normally a stimulus applied to the knee does not cause anyone to arch his back. In certain abnormal conditions, however, the resistance is overcome and a simple stimulus will spread over a very wide area. In strychnine poisoning the resistance is so lowered that a tiny stimulus, like a crack of light between the curtains or a touch on the skin, may send the whole body into convulsions.

Facilitation: this means that if a stimulus is repeated, short of fatigue, the arc seems to learn to respond to it more easily. Thus there appears to be a certain element of "practice makes perfect," even in an action which is purely reflex.

Inhibition: the central nervous system will only respond to one thing at a time and if two stimuli are applied simultaneously one is attended to at once, the one most vital to the life of the organism, while the other is temporarily inhibited and then attended to in its turn.

Reinforcement: when stimuli are applied to two or more receptors which both go eventually to the same effector, the two reinforce each other, so that a larger response is obtained through the one effector than would be obtained if the stimuli were limited to the path from one receptor only.

Simple reflex actions are all inherited and are shown by the baby at birth, when they are just as efficient as they are in an educated adult. Normally also, the reflex is entirely independent of consciousness or will. An individual may become aware that he is performing a reflex action, but it is happening before his consciousness can take any part in it.

Control of Reflexes

There is a certain limit within which certain reflexes can be controlled by the will. For example, it is a reflex action to snatch the hand away from a flame, but there are cases on record of people who have overcome this. The martyr Cranmer is described as holding out to the flame the hand which had recently signed his recantation.

It is a reflex to sneeze when an irritating particle touches the sensitive lining of the nose, but it is sometimes possible to stop the sneeze by pressing firmly on the upper lip, thus sending a stronger stimulus which, so to speak, distracts the nose from sneezing.

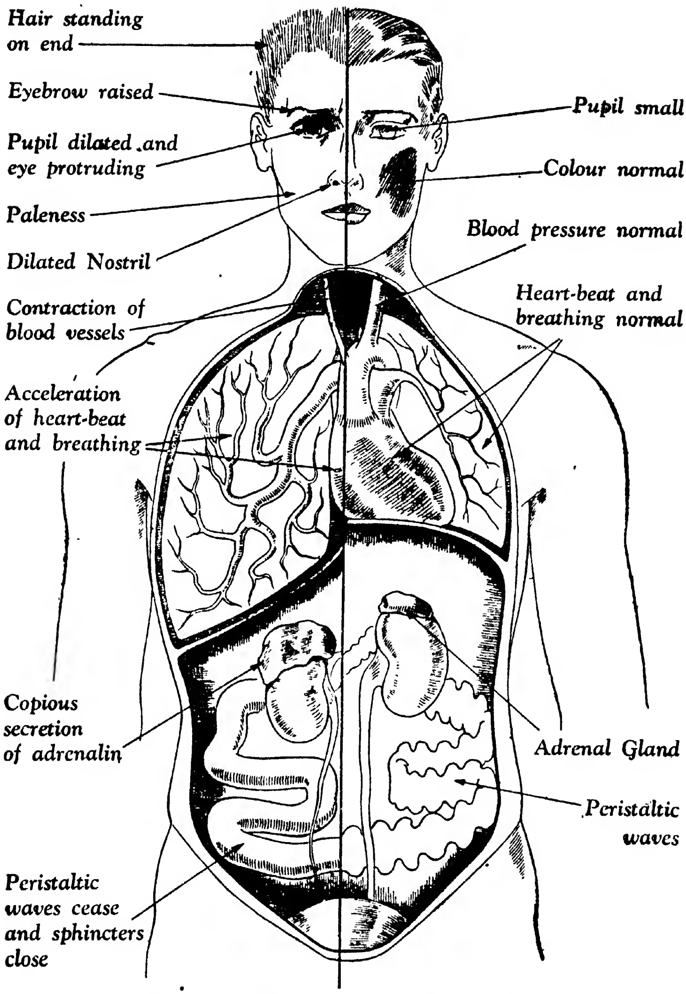
Autonomic Nervous System

The vast majority of reflex actions in daily life, however, are concerned with things like digestion, maintenance of body temperature, and the perpetuation in the body fluids of the right kind of chemical composition. The system dealing with these unconscious vital processes is called the autonomic nervous system.

The cells of the neurones of this system lie in a chain of swellings found outside the spinal cord, and outside the vertebral column, but they have fibres connecting them with the corresponding parts of the spinal nervous system, and they work in with it.

The autonomic nervous system is divided into two groups which oppose each other, known as the sympathetic and parasympathetic nerves. The two together act very much like the reins guiding a horse. Both of them are always in action to some extent, and activity is maintained as a balance between them.

From time to time, however, there is a special note of alarm and the sympathetic nerves come into action. The picture they produce might be described as that of the "frightened lady." Some fibres pass to the pupil of the eye and dilate it



HOW THE NERVES REACT TO DANGER

The sympathetic nerves come into action in the presence of danger (left), and are in opposition to the parasympathetic nerves, which restore normal activity (right). Normally the two systems act together, keeping a balance.

so that as good a view as possible can be obtained of the threatened danger; others pass to the muscles around the eye and push it forward, again to increase the range of vision; while, at the same time, the upper eyelid is lifted to the fullest extent. The nostrils are dilated, the lips may be parted, and the breathing is quickened to ensure an adequate supply of oxygen to the tissues.

The whole of the digestive system is told to "go easy" so that the blood can be spared for mechanisms of fight or flight. The digestive juices, therefore, are not produced and of this we are made aware by a dry mouth. The skin is moistened with sweat so that it may be smooth and slippery in case the body has to wriggle out of a dangerous embrace. The small vessels which supply it are reduced in size so that there will not be much bleeding if there is a wound: hence the pallor which goes with alarm.

The condition of goose-skin is not much help to man, but is due to stimulation of the remains of the little muscles which pull the hair erect. This is very valuable to furry animals because it makes it more difficult for the enemy to get a mouthful of anything but hair.

Direction of Blood Flow

Other fibres from this system accelerate and increase the force of the heart-beat, so that the blood is pumped round more powerfully, and at the same time they redirect the flow of blood, like police at diversion signs, so that it is reduced to a trickle to all the temporarily unimportant parts which can wait, and sent instead to the parts on which life may depend: muscles, brain and lungs. The movements of the intestine (the peristaltic waves) and the production of its glands are reduced and the sphincters are closed.

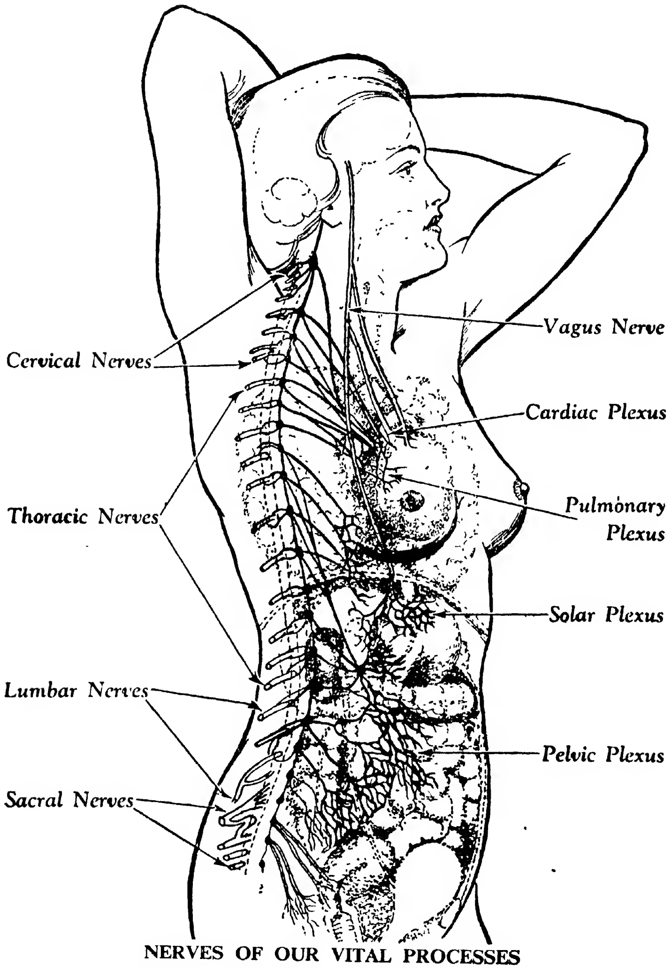
Parasympathetic Nerves

The parasympathetic nervous system undoes all the special work produced by the danger signal and sends out the general order to carry on with normal activities. It is a protective system, guarding the heart, lungs and other vital organs from overwork and excessive response to stimuli.

With all these things will and consciousness are never concerned and the autonomic nervous system, therefore, plays a relatively small part in the conscious life of man.

Lower animals can carry on their lives very much the same if their brains are removed, since a large part of their activities is purely reflex. Thus, a frog without a brain will swim when thrown into a pond because the stimulus of the water makes his legs move. He will catch, eat and digest a fly which perches on his nose, because the stimulus of touch near his mouth makes him snatch, catch and swallow.

Even a dog without a brain will walk a few steps if stood on his legs because the stimulus of ground under his pads makes the muscles



NERVES OF OUR VITAL PROCESSES

The autonomic nervous system deals with the unconscious vital processes, such as digestion, maintenance of body temperature and fluids, and its receptors convey information to the brain. The sympathetic nerves branch from the spinal cord and form networks which supply the areas concerned. The vagus nerve is the main nerve of the parasympathetic system.

move. If, however, the dog comes to an obstacle he falls down because reflex activity cannot show him how to get over or round a difficulty. But man can do very little if his nervous system is reduced to a spinal cord only.

We have therefore to consider how it is that so many of the stimuli which fall on the receptors in man get passed to his brain and evoke conscious sensation, while his responses are not instinctive and reflex but considered and willed.

If the tendon below the kneecap is tapped, the receptors of touch in the skin and tendon pass a message up the nerve to the nerve cell in the lower part of the spinal cord somewhere in the small of the back. Then, via various interpolated neurones, the message passes to the efferent neurones and comes back to the muscles of the thigh, which make the foot kick out involuntarily (see diagram on page 213). This will happen even if consciousness is absent and will in abeyance.

Voluntary Action

If, on the other hand, a ball trickles away from its owner and comes to rest against the toe of a passer-by, the kick which he gives it is of a very different sort. The message passes up the same nerve to the same centre in the small of the back, but it does not turn there and start its return journey. It is passed to another neurone, which goes on right up the rest of the spinal cord to the back of the brain and there is put into communication with all those parts of the brain which determine poise and position and muscular co-ordination.

Only with the help of these centres can the man kick the ball, with the right degree of force and in the right direction, without losing his balance. If all he were concerned with were avoiding the ball so that he did not trip over it, the message might stop here and start going back to his feet, and this would be a form of reflex activity, although a higher kind of reflex than that which makes the foot kick after a knee tap.

Postural Reflexes

The activities which take place in the back of the brain are called postural reflexes, and they are concerned with the maintenance of balance and the righting of any disturbance such as might be caused by "treading on a stair which wasn't there," or to a passenger in a motor car swinging round the corner.

But the stroller who is going to kick the ball back to its owner wants more than this, and from the back part of his brain a third neurone picks up and carries a message on to the front of the brain. Here sensation of touch on the toe, with which we started, is co-ordinated with the sensation of sight: the size of the ball, where it is, and the distance and direction of the owner.

All this information is put together and translated into a

message which can be passed to the centres of voluntary movement, called the motor cells, in the front of the brain. The will says to these cells: "Kick that ball in that direction"; the message is passed down one long neurone straight from the brain to the small of the back, and then relayed to a second neurone which translates it into exactly the right kind of muscular contraction to carry out the desired activity.

All this happens with extraordinary rapidity. The impulse travels along a nerve at the rate of about four hundred feet a second, though, as every one knows, it travels a little more slowly when the nerves are cold.

The receptors of the human body can, therefore, be divided into those which receive messages ultimately destined to reach consciousness, and those which receive stimuli which never affect the conscious mind.

The unconscious ones are in two groups: those which are situated all over the organs inside the body, and some of those which convey impressions of position and condition from muscles and joints.

Receptors of Internal Organs

The general visceral group is so called because the majority of the receptors are found in the viscera, or internal organs. These are the ones on which we depend every moment for the continuance of our complicated life. They convey to parts of the brain of which we have no knowledge information from moment to moment about the condition of our internal organs and the fluid which bathes them.

Sensation of Pain

Their mechanism is inborn and requires no practice. They are delicately adapted to the special life of the animal and are alike in all members of the species or race. The only sensation they ever convey to our brains is the sensation of pain. Stretching the muscles of the intestine causes painful sensations which are apparently due to tension on the receptors.

The great majority of these general visceral receptors send their messages through the autonomic system, though a few are in direct connexion with the brain.

The second set of unconscious receptors constitutes some (but not all, because some of these are conscious) of the proprioceptive group, described on page 154.

All the receptors show certain general properties. They have a threshold; as explained in discussing the reflex arc, a very small stimulus does not get over the threshold of the receptor. They show fatigue and facilitation and summation, as described also under reflex arc (see page 145). The more highly a receptor is developed, the more limited its appreciation of environmental change.

Exactly how receptors act is not fully understood, but in some way they excite a nerve fibre and send a series of about one hundred

impulses a minute along it. They usually act in groups.

There is no real resemblance between a stimulus and the sensation it produces, but since the sensation is the only means we have of appreciating the stimulus, we naturally tend to confuse them. The stimulus is any change in the environment of an excitable tissue which, if intense enough, will make that tissue show its particular form of excitement. The sensations are sight, hearing, and so on.

Effect of Stimulus on Receptors

Any kind of stimulus applied along any part of the afferent path will provoke the same sensation: for example, if the nerve of the eye is pinched, the eye knows nothing of the pinch, but records a flash of light; if the receptor of the ear is tickled, or stimulated in any other way, the sensation will still be that of a sound. An electric current to the tongue will cause a sensation of taste.

We do not know for certain if this limitation is due to the receptor or the centre, but it is generally thought that it is the activity of the centre, so that if a nerve from the ear could be led to the eye part of the brain, sounds would be interpreted as sight. Such experiment is beyond us at present, but perhaps some time in the future a surgeon will do a nerve-grafting operation which will make his patient hear the lightning and see the thunder!

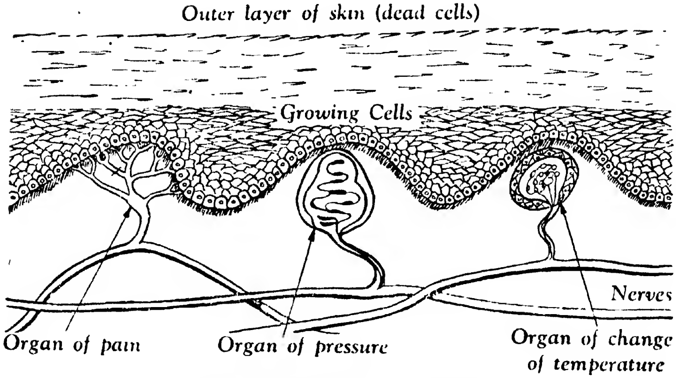
The receptors of the human body which supply information to the conscious mind are often called the five special senses: the skin and feeling; the tongue and tasting; the nose and smelling; the eye and sight; and the ear and hearing. We will deal with these in detail separately.

The skin is studded all over with receptors which deal with touch, temperature, danger stimuli and position. They are divided into two groups: those which are stimulated by changes outside the body, and those which are stimulated by changes in the muscles and joints. The former, called exteroceptive, convey sensations of touch, temperature and pain.

Sense of Touch

The special receptors which send messages recorded as touch are microscopic plates found all over the skin and at the roots of the hairs. They are particularly numerous in sensitive places like the tips of the fingers, forehead, lips and tongue, and relatively sparse, for example, between the shoulder blades.

If two compass points tipped with cork are held a millimetre apart, the tongue will recognize them as two different stimuli; meaning that, even so close together, the two points are touching at least two receptors. In the tip of the finger they have to be two and a half millimetres apart before they are felt as two, and on the back of the arm or on the thigh they have to be as far apart as sixty-seven millimetres (i.e. nearly three inches).



NERVE ORGANS OF THE SKIN

Dotted over the skin are tiny organs at the nerve endings which convey the sensations of pain, temperature and touch, or pressure. Pain organs are uniformly distributed; touch organs are more numerous in sensitive places, such as the finger-tips; while the organs of temperature are more widely spaced, the cold spots being four times as common as the warm spots.

Those recording temperature are less freely scattered, and it is possible to map out the areas of the skin which are sensitive to warmth and cold respectively. The "cold spots" are four times as common as the "warm spots."

Temperature sensations are best evoked on the chest and the nose, in front of the arm and on the abdomen. There are very few of them in the lining of the mouth, which is the reason why scalding tea can often be drunk without distress.

The temperature receptors are very adaptable, as you can see for yourself by a simple experiment. Put one hand in a basin of hot water and the other in a basin of cold water, and leave them there for a few minutes so that the receptors adapt themselves. Then put both hands into a basin of tepid water. To one hand the water will feel hot and to the other it will feel cold.

It is not yet quite certain whether pain is conveyed by special receptors or whether a strong stimulus to any receptor may be recorded as painful. There seems to be a real difference between the conduction of pain and that of other sensations, and in one or two places—such as the cornea or transparent layer over the coloured part of the eye—pain is the only sensation ever produced by any kind of stimulus.

Pain is all-important for the preservation of the organism and, therefore, the receptors for it

are more uniformly distributed than the others. The pain perception can be abolished by certain drugs which are known as analgesics.

The second group of surface receptors is called the proprioceptive receptor group, and these convey the precise condition of muscles, tendons and joints. It is due to their activity that you can find your toe in the dark and can supply to each movement just the right amount of force needed for it.

If they go wrong, as sometimes happens, the doctor will probably test them by asking you to put your finger on the tip of your nose with your eyes shut, and you will be surprised to find that you cannot find your nose at all. Another thing that happens when they go wrong is that you lift a cup of tea with as much energy as you would use to lift a sack of potatoes—and the tea goes over your shoulder.

Sense of Balance

A very important group of these proprioceptive receptors is found in a part of the internal ear, though it has nothing whatever to do with hearing and just happens to be placed so close to the ear that anatomically it is described as part of it.

This receptor consists of three very tiny hollow semi-circles of bone—the semi-circular canals—and of a complicated hollow in the bone called the labyrinth. Inside the labyrinth are little fragments of lime embedded among very fine hairs. When the head is bent on one side the hair is bent one way or another by the weight of the lime particles, and the messages received from these receptors enable the centre to tell the position of the head in great detail.

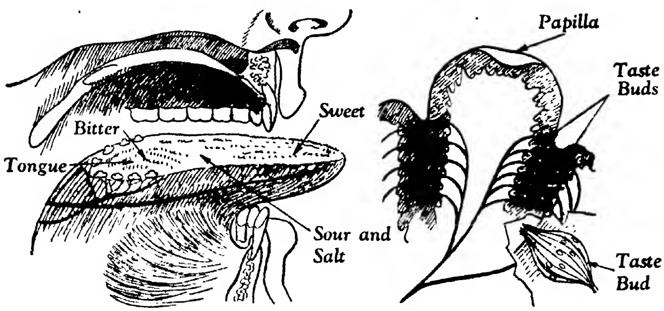
Why We Feel Giddy

The fluid in the canals swishes as the head is moved, so they convey information about head movements. Because the fluid takes a little time to swing back to normal after a complicated twirl, people feel giddy after twisting round and round. Dancers give a quick little jerk to their heads after a pirouette, so as to swing the fluid in the opposite direction, and thus they prevent this giddiness.

When these receptors go wrong—which they very rarely do—people become giddy without any cause because they get the most confusing impressions of the positions and movements of their heads. If the receptors are destroyed in birds or mice, the birds will tumble over and over in the air as they fly, or the mice will twirl round in circles as they run.

The baby has all these receptors working, but has not learned to co-ordinate them. Thus, it has to learn the results of its own movements: the position of its limbs, and how to follow objects with eye and hand. The eye can do a great deal to make up for deficiencies in these other sense organs.

The second special sense, that of taste, is described fully in an earlier



HOW WE TASTE

In the diagram of the tongue on the left the V-shaped line of papillae is seen at the back of the tongue and the different areas where sweet, salt, bitter and acid are distinguished. The taste buds are situated in the papillae, as shown in the enlarged papilla (right), and in the lower right-hand corner a single taste bud with its taste cells is shown highly magnified.

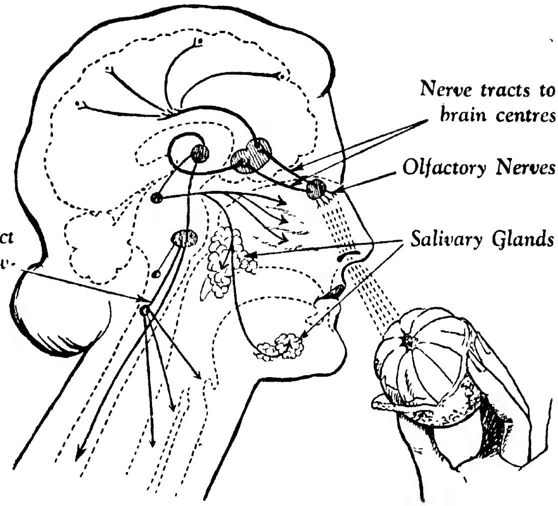
chapter (page 108). We saw that most of the taste buds lie along a V-shaped line towards the back of the tongue. The taste buds can distinguish only between sweet, salt, bitter and acid.

We learnt also that every other taste we know is really experienced in our noses, by the special sense of smell. This sensation is produced by messages coming from special receptors (olfactory nerves) which lie between the tall palisade-like cells lining the upper and back part of the nose.

The front part of the nose is only concerned with warming the air as it goes on its way to the lungs and has no sensation of smell. That is why one has to "snuff up" to get a good smell impression. Smell has become much less important in man than in the animals, but it is a very old and deep sensation and sometimes the associations roused by a smell are very vivid and may go back for many years.

The receptor for sight is the lining of the back of the eyeball called the retina. All the rest of the eye is concerned with bringing the rays of light to a suitable focus on this sensitive plate. The outer coat of the eyeball has a tough protecting membrane called the sclera, but in the front this gives place to a round transparent window called the cornea. The front part of the eyeball is covered by a delicate mucous membrane which also turns back at the top and the bottom of the front of the eyeball to line the eyelids. This is the conjunctiva.

Tucked away in the outer corner of the upper lid is a small gland, or factory, producing tears. Tears are not only produced when we cry



HOW THE SENSE OF SMELL WORKS

Tiny particles given off by the object enter the nose and are received by the olfactory nerves at the top of the nose. These communicate with the brain centres concerned with smell. The brain centres in turn send messages to the salivary glands to pour out saliva, thus producing the preliminary stages of digestion. The diagram also shows how messages are sent from the brain to the reflex-swallowing apparatus which prevents us from choking.

but are being poured out all the time in small quantities, and the front of the eyeball is flushed every few seconds by the muscular reflex action of blinking.

The muscles of the lid are so arranged that when the eyelids close, a squeegee effect is produced, pushing the fluid out of the lachrymal gland across the front of the eyeball down through a little drain at the inner side of the eye. This little channel conducts the fluid to the nose, where it evaporates. Of course, if there is an excess of fluid, it cannot all be evaporated and so we have to blow our noses after crying, or when the wind is keen and excites a flow of tears to prevent drying of the eyeball.

Inside the sclera there is a delicate network of very small blood-vessels which nourish the tissues of the eyeball, but since even the smallest blood-vessels crossing the cornea would spoil the passage of light to the retina, this vascular layer—the choroid—does not extend round the front of the eyeball.

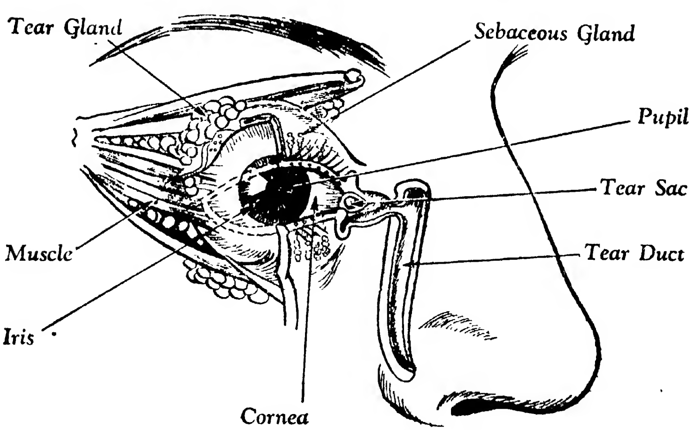
Instead, the back of the cornea

and the tissues in the neighbourhood are nourished by a clear watery fluid called the aqueous humour. The cavity containing the aqueous humour is shallow and lies between the cornea in front and the lens behind.

The lens is suspended in a transparent capsule which is attached to the sclera at the sides, thus forming a sort of curtain across the eyeball. It is just like a lens made of glass except for its elasticity. The capsule is acted on by muscles which pull on its attachment to the sides of the eyeball, and when it is tightened, the lens is flattened and reflects the rays less than when allowed to expand. By means of this variable lens, rays coming from very varying distances can be made to converge to a point precisely on the retina, and this is how we are able to see both near things and distant things.

The process by which the lens changes its thickness is called accommodation. With old age this becomes a little less free and, therefore, the eye of the older person finds difficulty in focusing close objects and has to be helped by a spectacle lens put in front of it.

Behind the lens lies another cavity, constituting about two-thirds of the eyeball, and this is filled with a sticky transparent substance called the vitreous



STRUCTURE OF THE EYE

The receptor for sight is the retina at the back of the eyeball, and the rest of the eye, including the pupil, iris and cornea, focuses the rays of light on the retina. The eyeball is continually flushed by fluid from the tear glands and this drains away through the duct in the nose. The sebaceous glands produce an oily substance which prevents the eyelids from sticking together.

humour. At the other side of this is the back of the eyeball with the retina laid upon the choroid and sclera.

The eye is the most delicate of all receptors because it is really a piece of th[illegible]n pushed out to the surfac[illegible]ry early in embryonic life, two little outgrowths appear near the front of the central nervous system tube, and these grow out towards predetermined places on the skin of the head (see illustration on page 18).

At these places the skin begins to undergo special changes and to grow in to meet the outgrowing brain tubes. The skin forms the lens of the eye, and the brain tube, dimpled to receive the lens, forms the cup of the eyeball. Thus the retina is a specialized piece of brain tissue, and in many ways looks like brain under the microscope. Among its cells are two special kinds of receptors called rods and cones. These are shaped as their names imply, and immediately beneath them lies a layer of pigment.

Rods and Cones of Retina

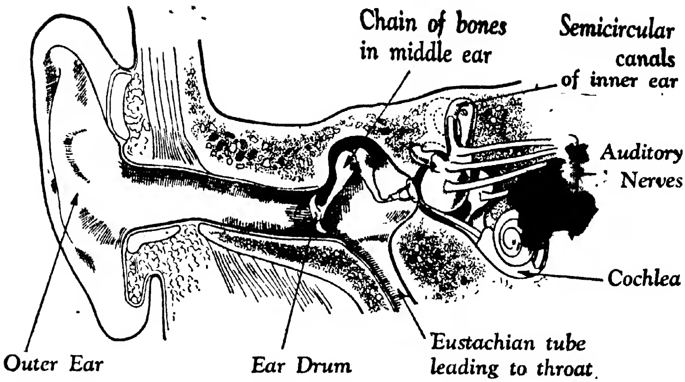
The cones work best in a good light, and for objects which are in the centre of the field of vision; the rods are most numerous at the edges of the retina and work best in a poor light. It is for this reason that in the dusk we can see better if we do not look quite straight at the object but look just beside it, so that the edge of the retina receives the stimulus and the rods are used as receptors.

When light falls on the retina, the pigment which lies in the surface layer goes deeper and floods around the rods and cones. It is also bleached and loses its purple colour. The cones become shorter; the chemical action of the retina becomes acid; and as a result of these changes, an electrical response, rather like the current which runs along a nerve, is set up, and the stalk (called the optic nerve, though it is not a nerve like other nerves, but an outgrowth of brain) begins to carry messages which we interpret as sight.

How We Hear

The fifth and last special sense is that of hearing. Inside the ear there is a passage which is closed at its far end by a membrane stretched across it just like a drum head. This membrane vibrates when sound waves fall upon it. On the other side of it lies a cavity called the middle ear which is filled with air and has a passage leading from it to the back of the nose. This enables the pressure in the cavity to be adjusted to the atmospheric pressure outside.

If the air pressure on the two sides of the drum were not kept the same, the drum would be stretched and would not be able to do its work properly. Airmen have learned the value of swallowing when they are changing height rapidly and so changing the air pressure round them. Swallowing opens the tube between the nose and the middle ear, and this equalizes the pressure.



HOW SOUNDS ARE HEARD

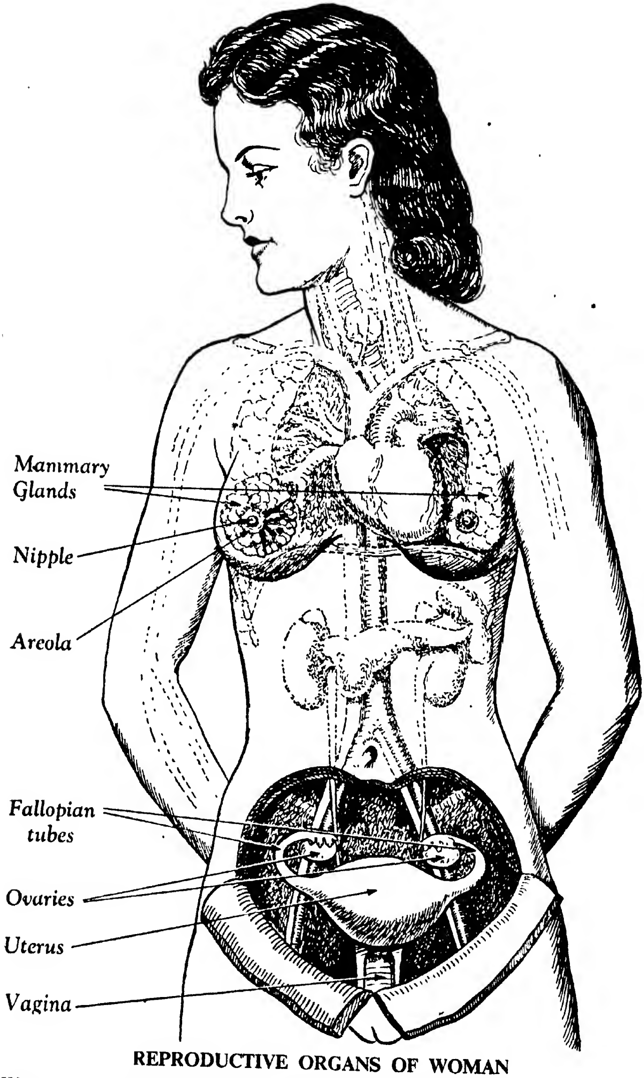
Sound waves enter the ear passage and strike the ear drum. This vibrates the little chain of bones in the middle ear and the impulses are passed along to the inner ear, which is a closed maze-like space with thousands of hair-like fibres of various lengths, each of which vibrates to a different note. These vibrations are transmitted to the brain by the nerve of hearing.

In this middle ear there are three very small bones known, from their shape, as the hammer, anvil and stirrup. The first of these is attached to the drum on one side and to the middle bone on its other side, and the middle bone is attached to the third bone, which fits into a small oval window in the skull.

Through this complicated mechanism air vibration in the outer ear is conveyed across the middle ear to the inner ear, which lies on the other side of the oval window. The window is filled in by a membrane and the inner ear is a closed maze-like space in the skull and is filled with fluid. When the fluid is vibrated by the membrane, which in turn is vibrated by the little bone which lies against it, then the waves in the fluid excite the receptor for hearing.

This consists of some very fine hairs, growing from a base membrane, with a wisp of tissue floating in the fluid above them. Each fibre of the base membrane is of different length and vibrates to a sound of its own pitch, just as the strings of a piano are of varying lengths which vibrate to different notes.

The human ear is very sensitive to differences in pitch, and distinguishes between vibration rates differing by one hundredth of a second. The base membrane contains about twenty-four thousand of these hair-like fibres. Finally, the vibrations of the fibres are transmitted to the brain by the nerve of hearing.



REPRODUCTIVE ORGANS OF WOMAN

Woman's reproductive organs are chiefly inside the body and consist of two ovaries, two tubes, a womb (uterus) and a vagina leading to the outside.

CHAPTER SEVEN

HOW WE REPRODUCE OURSELVES

Primitive methods of reproduction. Male sex cells, or spermatozoa. Male organs of reproduction. Female reproductive organs. Ripening of an egg cell. Conditions necessary for successful fertilization. Function of the yellow body during pregnancy. Chromosomes in the reproductive cells. How sex is determined. Transmission of characteristics. Theories of heredity.

We have already seen how the simplest form of organism, the amoeba, reproduces itself by splitting in two. The experiment of reproduction by budding off the new individual from the old did not seem to be successful, and very low in the animal scale was established the bisexual pattern of having male and female parent, with a cell from each to make the next generation.

We have also seen how the problems of land life led to the development of the mammalian organs of reproduction, the penis and the womb.

In Chapter Eight (see page 186) will be described how the two glands of reproduction (testis in male and ovary in female) each consist of two kinds of cell. One kind, called the interstitial cells, produces a substance which circulates in the blood and gives the whole body its male or female appearance and constitution. The other kind produces the special cells which are going to form future individuals; these are called spermatozoa in the male and ova or egg cells in the female.

Millions and millions of spermatozoa are created and wasted; this seems to be a relic of the days when we lived in water, early in our evolutionary history. It is still true of fish that many millions of eggs are fertilized and wasted because they have to develop while floating about unprotected in the sea, where they are subjected to many chances of destruction.

The spermatozoa are tiny cells, one three-hundredth of an inch long, each with a large nucleus and a long whip-like tail. The tail thrashes about in fluid, and enables the cell to dart from place to place.

The two testes are formed in the body of the baby round the region of the loin, and appear outside the body just before birth. The mechanism by which they make their descent is a curious one. There is a cord running from the lower end of each testis to the groin. The distance in the foetus before birth is, of course, very much less than in the baby at birth, and it increases gradually as the baby grows.

Since the cord cannot stretch, but on the contrary shrinks a little, the testis, which is not attached at its

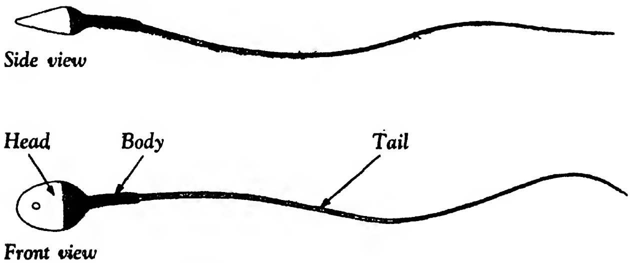
upper end to anything, is bound to be drawn down towards the lower attachment of the cord. While it is on its way, the skin round this lower attachment pouches out into a little bag with two compartments, one for each testis. This is called the scrotum, and is characterized by its curious dark wrinkled skin with fat beneath it, and by crisp curly hairs which appear at puberty.

Each testis is an oval gland weighing an ounce or less. The part from which spermatozoa are made consists of closely packed minute little tubes known as the seminiferous tubules. All the little tubules run together into one large tube, and this is very many times folded on itself and packed closely alongside the testis. This part is called the epididymis.

This finally comes out of its many folds at the lower end of the testis to form one straight canal, the vas deferens. This canal, together with some arteries and veins and lymphatic vessels, runs up from the scrotum to the lower part of the abdomen, where it passes through the muscles forming the abdominal wall to enter the abdominal cavity. The combined structures are called the spermatic cord.

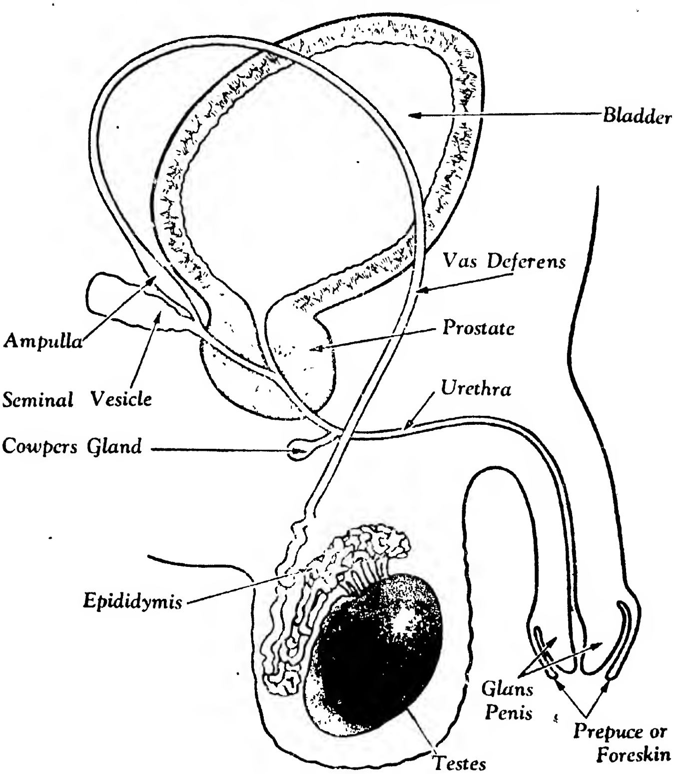
Inside the cavity the vas deferens turns downward again, and into it there opens a small "waiting room," or little sac, known as the seminal vesicle, where the spermatozoa are stored until they are wanted. Beyond the channel or passage which leads to the seminal vesicle, the vas deferens is called the ejaculatory duct, and runs through the prostate gland to end in the upper part of the urethra, that is to say, the canal which normally conveys urine from the bladder to the exterior.

The prostate gland is a circular gland, about the size of a chestnut, which surrounds the neck of the bladder and the first part of the



MALE SEX CELL MAGNIFIED

These diagrams show the side and front views of the male sex cell (spermatozoon), which consists of a head, containing the nucleus, and a long whip-like tail. The tail thrashes about, thus enabling the cell to travel in the fluid of the vagina and womb. After fertilization it has no further use and drops off.



SECTION OF MALE REPRODUCTIVE ORGANS

Spermatozoa are manufactured in the testes, travel along the vas deferens, and are stored in the seminal vesicles. Secretions which help the mobility of the spermatozoa are produced in the seminal vesicles and prostate gland.

urethra. It pours a secretion into the urethra about an inch from its beginning, near where the ejaculatory ducts open into it. The seminal vesicles produce a fluid, which seems to help the mobility of the spermatozoa, and this is probably also the function of the prostate gland, but we do not yet fully understand this subject.

The third fluid which is poured into the urethra comes from two little glands known as Cowper's glands. It may be that this fluid

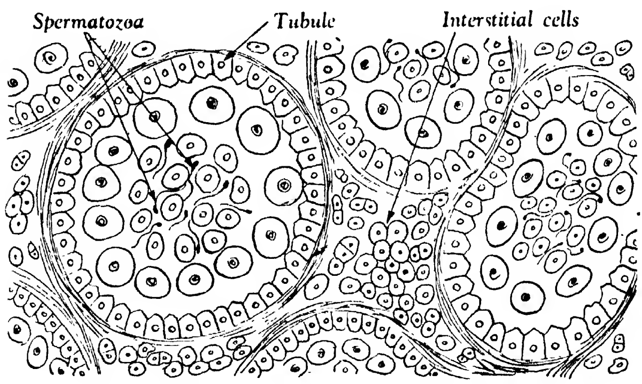
neutralizes the acidity of the urine, for the spermatozoa do not like an acid environment.

The result of mixing all these together is a sticky, rather milky fluid called seminal fluid, which is jerked out through the length of the urethra during the sexual act, the average ejaculation containing several hundred million spermatozoa. At the moment of ejaculation the two seminal vesicles are emptied into the urethra.

The body of the penis is composed of very loose spongy tissue which, under the influence of sexual excitement, becomes so filled with blood that it is rigid, and can be thrust into the vagina of the female so as to reach the mouth of the womb.

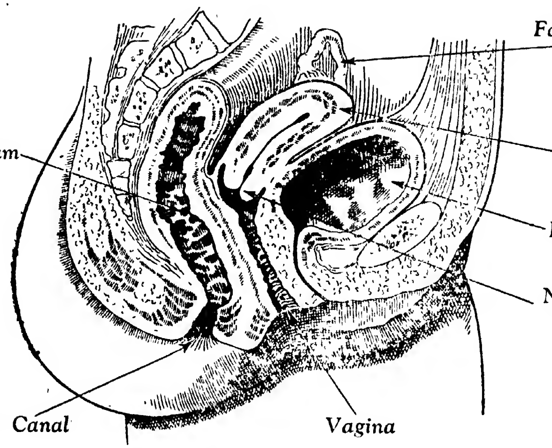
This change from limpness to stiffness is due to nervous impulses from the brain acting on a centre in the lower part of the spinal cord, and exciting certain nerves called the nerves of erection. These messages bring about a dilation of the little blood-vessels of the penis, which organ, accordingly, becomes full of blood. The nervous reactions are brought about by the stimulation of receptive cell termini which send, as it were, telegrams to the brain.

The rounded end of the penis is known as the glans and the urethra opens through it by a vertical slit. The circular fold of loose skin which normally hangs over and covers the glans is known as the prepuce, and it is this piece of skin which is removed in the operation of circumcision.



HOW MALE SEX CELLS ARE PRODUCED

Section of a testis enlarged many times, showing spermatozoa being formed in the seminiferous tubules. Between the tubules are the interstitial cells which manufacture the internal secretion concerned with other male characteristics—growth of hair, shape of body and deeper voice register.



REPRODUCTIVE SYSTEM OF WOMAN

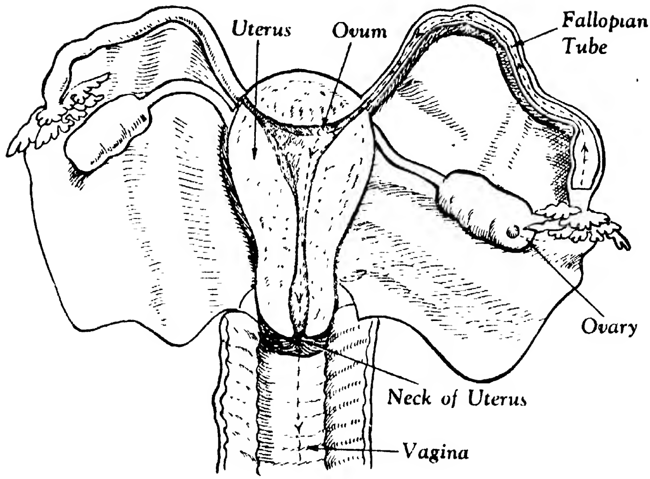
This cross-section shows the female reproductive organs in relation to the surrounding organs. Compare this diagram with that on page 28, showing the womb expanded to many times its original size to accommodate a full-term baby, and note how the other organs are closely packed around it.

The female reproductive organs are mostly inside the body and consist of two ovaries, two tubes (Fallopian tubes), a womb and a vagina leading from it to the outside.

Beginning from the outside a woman has two fleshy lips, arranged vertically, after puberty more or less covered with hair. These lips constitute the vulva. Within the opening which they guard are two lesser lips, the inner vulva. They produce a secretion which, during intercourse, is poured out and acts as a lubricant.

Nearly at the apex of the outer lips is a little bulb called the clitoris, corresponding to a sort of miniature penis. Just as the penis acts as a sexual excitant, so does the clitoris. The clitoris is situated on a sort of swelling called the *mons veneris*—the mountain of love. Just below the clitoris, within the inner lips, is the opening of the female urethra, through which urine is voided from the bladder.

The vagina itself is below the urethral opening. It measures from three to five inches in length, and is closed at one end. When in its normal state of relaxation it is collapsed and tightly closed; but it is capable of great expansion, its walls being composed of folds of muscle-tissue which permit the stretching that is necessary during



DISCHARGE OF AN OVUM

Each month an ovum ripens and bursts from the ovary, finding its way into the Fallopian tube. If it is fertilized by a spermatozoon on its journey through the tube to the womb, pregnancy begins. If not, it passes into the womb and is discharged through the vagina during menstruation.

child-birth, when the baby passes from the womb to the outer world by way of the vagina.

Each ovary is a body rather like an almond, consisting of dense tissue made up of supporting cells, interstitial cells (which produce the internal secretion giving the body its feminine bias) and the special reproductive cells which undergo a maturing process before they are discharged from the ovary. One ovum only is supposed to be discharged each month during the years between puberty and menopause.

Thus the female system is characterized by extraordinary economy, while the male shows such remarkable extravagance. In a new-born baby there are some thirty-six thousand potential egg cells and the first ripens at puberty. The ripening is stimulated by the internal secretion from the pituitary. First of all, the cells surrounding the egg cell multiply rapidly, and then fluid appears between them so that a little cyst or bladder is formed round the egg cell. This cyst swells, and works towards the outside of the ovary, where it projects like a bleb, making the ovary look almost double its normal size.

Finally the pressure of the fluid

bursts open the cyst, and the egg cell is then shot out from the surface. It is a large cell, as cells go, since it contains a great quantity of nourishing material, represented by the yolk of the hen's egg. It is about a one hundred-and-seventy-fifth of an inch in diameter: just visible to the naked eye.

When it is set free, it is loose in the abdominal cavity, but the Fallopian tube expands at its end nearest the ovary and has a number of long finger-like processes which reach out towards the ovary and were given in medieval times the fanciful descriptive name of *morsus diaboli*—which means the grasp of the devil.

There is probably also a certain amount of suction into the mouth of the tube, and the ovum normally finds its way into it quite safely.

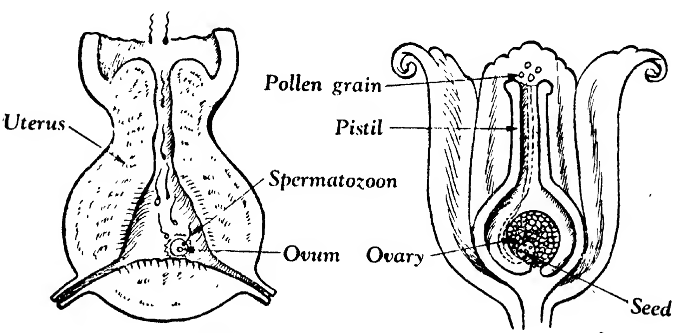
If it meets a virile spermatozoon in the tube, it is fertilized: if not, it passes on into the uterus and thence into the vagina, and so is discharged unperceived and lost.

The possibility of successful fertilization therefore depends partly on the presence in the tubes of an ovum to be fertilized and partly on the capacity of one of the many millions of spermatozoa to fertilize it.

The spermatozoa move about most actively in a weakly alkaline medium, and sometimes failure may be due to too much acid in the female passages.

They also move more vigorously if they have plenty of oxygen. (In the male passages they are packed tightly and the lack of oxygen keeps them passive.)

In addition to these requirements the spermatozoa like a certain level of temperature, rather less than



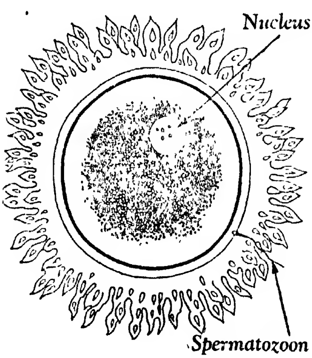
INSEMINATION AND POLLINATION

This comparison of fertilization in a flower and in the womb emphasizes the similarity of the two processes. Pollen grains travel down the pistil of the flower to the ovary to effect fertilization, just as spermatozoa enter the vagina and travel up to the womb to meet the ovum on its way from the ovary.

that of the temperature of the body; the reserve ones are therefore held at the lowest point of the scrotum, farthest away from the body, where the temperature may be approximately ten degrees below that of normal body heat.

This curious demand for coolness seems to be at least one of the reasons why the testis cannot work inside the body but has to be hung outside it in a bag. In hot weather the bag stretches to allow the testis to fall away from the hot body, while in cold weather it contracts and holds the testis close up to the body.

Inside the female passages, therefore, the spermatozoa cannot live for very long and probably only last for about thirty-six hours,



PIERCING OF OVUM

The spermatozoon, after piercing the thick cell wall of the ovum, sheds its tail, and the nucleus in the head end fuses with the nucleus in the ovum, thus creating the combined germ cell which is to form the new individual.

with a maximum of three or four days. Under all these adverse conditions, and after such a long journey, it is not so difficult to understand that only the strongest spermatozoa can penetrate the thick cell coverings of the ovum and effect fertilization.

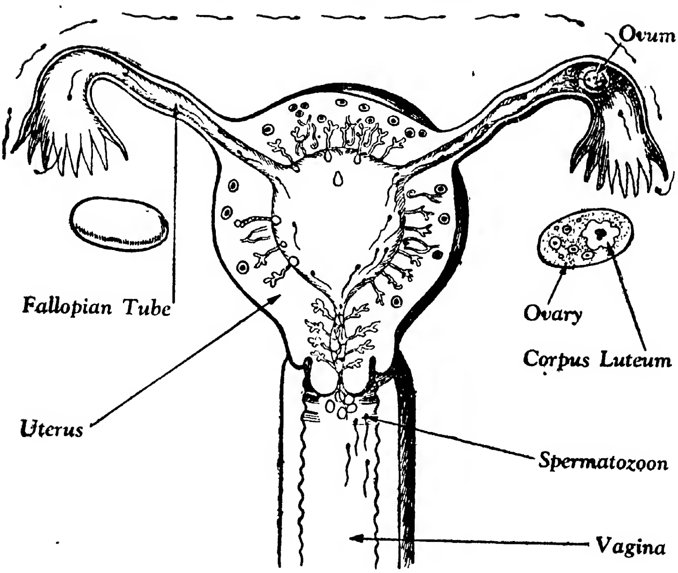
Formation of Yellow Body

When the egg cell has left the cyst, some changes take place in it which give it a yellow colour, and it is therefore called the corpus luteum, or yellow body. It has the appearance of a yellow capsule, with felted walls containing a dark red centre.

This yellow body has two different fates according to whether or not the ovum is fertilized. If the ovum is not fertilized, the blood clot in the centre is absorbed and the yellow body shrinks and crumples up, forming a pitted scar on the ovary. An old ovary is scarred all over in this way.

If, however, the ovum is fertilized and embeds itself in the uterus, then the yellow body does not shrink and disappear about the tenth day, but enlarges and produces an internal secretion which presides over the pregnancy. It degenerates and crumples up only after the baby is born.

Elaborate preparations are made to receive a fertilized ovum in the womb. The lining is built up until it is thick, spongy and full of blood, at its maximum thickness about four days after the egg cell escapes from the cyst. This, of course, is to



LONG JOURNEY OF SPERMATOZOA

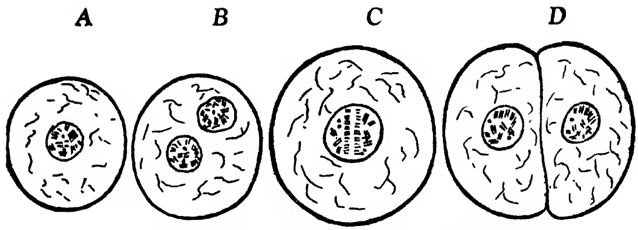
This diagram shows the long journey of the spermatozoa through the vagina and womb, and a successful fertilization being effected in the Fallopian tube. The corpus luteum, or yellow body, which develops and presides during pregnancy, is shown on the ovary where the egg cell was discharged. If the ovum is not fertilized this yellow body withers, leaving a scar on the ovary.

make a good "nest" for the egg cell, which reaches the womb in four or five days.

If, however, the egg cell has not been fertilized, all this preparation is wasted and there seems to be nothing to do with it but to break it all down again and throw away the extra cells and blood. This clearing out is the monthly discharge, called menstruation. It seems to start fourteen days after the rupture of the cyst in the ovary.

As explained earlier (page 11), every cell in the body has a fixed number of microscopic rod-like objects in its nucleus—the chromosomes. The number is absolutely fixed for any given species, but if the new individual of the species is to be formed after the fusion of two nuclei, one from its father and one from its mother, obviously it would have twice the proper number unless something were done about it.

What happens is that during the



HOW CHARACTERISTICS ARE TRANSMITTED

These four diagrams show how chromosomes, which transmit characteristics, are taken from both parents to unite in the new individual. (A) Egg cell with twenty-four chromosomes; (B) egg cell penetrated by spermatozoon with twenty-four chromosomes; (C) fusion of nuclei, making forty-eight chromosomes; (D) cell dividing into two. Chromosomes have split, half of every one going into each new cell. Sex is determined on fertilization.

maturing process the chromosomes in both the spermatozoa and the egg cells are reduced to half by a process known as reduction division. This takes place while the spermatozoon is passing down the tubes of the testis and just before or just after the discharge of the egg cell from the ovary. Thus a fertilized ovum, the result of fusion of male and female parent cells, contains just the right number of chromosomes for the species—forty-eight in man.

These forty-eight chromosomes are arranged in pairs in every living cell of the human body. One pair is different from the remainder and it is this pair which determines the sex of the individual. These two sex chromosomes are equal in the female and are represented by the letters XX. In the male the sex chromosomes are unequal and are called XY, Y chromosomes being smaller than X chromosomes.

When the chromosomes are reduced to twenty-four by division in the mature ovum and the mature sperm, the pair of sex chromosomes is split, so that while each ovum has one X chromosome, a sperm may have either an X or a Y chromosome. Thus an ovum fertilized by a sperm containing a Y chromosome will produce a male offspring and an ovum fertilized by a sperm containing an X chromosome will produce a female offspring. Sex is thus fixed at the moment of fertilization.

In addition to sex, the chromosomes transmit those characteristics which the new individual inherits from his parents and in turn passes on to his children. The problem of heredity is one which has interested and puzzled mankind for very many hundreds of years. People ask: what makes one person differ from another? Why do some have black hair and others

fair or copper-coloured hair? Why does a family nose or a family chin turn up in generation after generation? All these, and a thousand similar questions, are constantly being asked.

To all these questions we can only attempt here a very superficial answer. In order to account for the continuity of family traits, a great many theories have been put forward. In the Middle Ages, it was believed that the spermatozoon, or the ovum, contained a tiny complete human being, known as the "Homunculus." The invention of the microscope disposed of this picturesque imagination. Darwin held that the two parents contributed minute particles of all their tissues to the cells concerned with reproduction, passing on in this way their own peculiarities.

The view most widely accepted is that in the contents of the nucleus of the simple reproductive cells certain complexes exist which have the power of determining the course of development of the fertilized ovum. These germ cells are themselves the direct descendants of the germ cells of the parents, never having been absorbed into the general mass of the body cells, which act as the guardians and feeders of the race of germ cells.

Blending of Parental Germ Cells

The germ plasm is continuous from one generation to another, and the blending of the nuclear material of the two parents affords an explanation of why like should produce like, and at the same time why marked differences can exist between the parents and their offspring, and between the offspring themselves. The balance between the two strains of nuclear material may be affected by minute variations in environment, even within the womb.

What can be done to affect these inherited characteristics after birth, is a question which is of the highest importance to psychologists and sociologists. There seems, however, little doubt that what we call undesirable tendencies can, to a certain extent, be repressed and discouraged, or given a harmless outlet, while good and socially useful qualities may be encouraged. The view of the Mendelian school, however, is that the hereditary factor is all-important, and that no amount of individual betterment can affect the germ plasm.

Mendel's Theory of Heredity

The Mendelian theory is so named from its first originator, an Austrian monk, Gregor Mendel, who published the results of his researches into heredity in plants and animals in the year 1866.

The essence of his theory is easily expressed. Its first axiom is that the characteristics of organisms are due in great part to the presence of distinct character transmitted separately in heredity; its second, that the parent cannot pass on to offspring a character which it does not itself innately possess.

Each germ cell—ovum or sperm

—may contain or be devoid of any of these characters, so that each individual arising from the union of two of these germ cells may receive in fertilization a dose—as one might say—of a similar kind from each parent, or might receive none from either. Both parents might contain, say, a red characteristic, or neither of them might. In such a case, the offspring is known as pure-bred for the presence or absence of the characteristic in question. Where one parent contains the red character and the other does not, the offspring is known as cross-bred for that character.

A population consists, therefore, of three kinds of individuals: one class which is pure-bred for the presence of a certain character, both parents having possessed it; one class which is pure-bred for its absence, neither parent having possessed it; and a third class, the cross-breds, who have received it from one side only. Yet a plant, cross-bred for tallness, may be as tall as a pure-bred tall plant; a dwarf plant, however bred, cannot produce a tall plant. Not having tallness, it cannot transmit it.

Dominants and Recessives

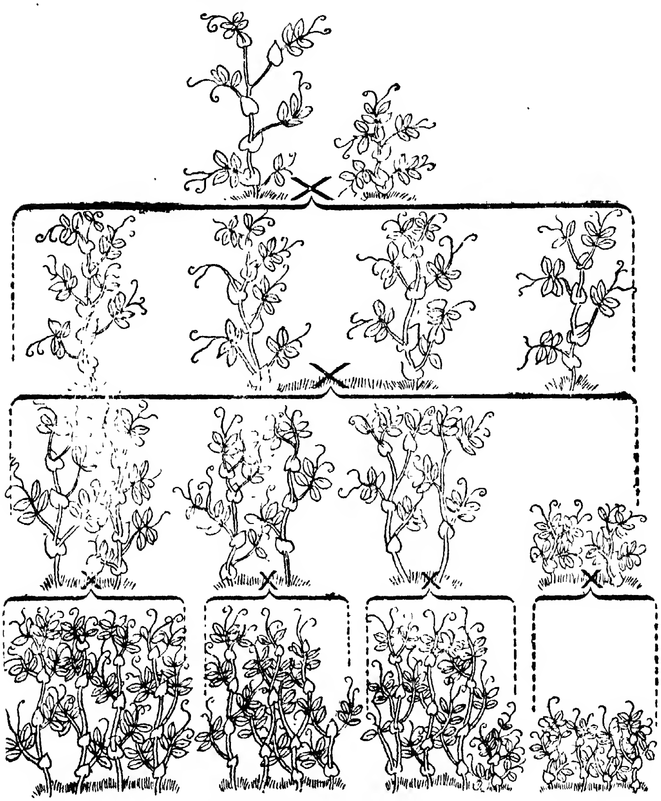
These curious results are due to the existence of two kinds of hereditary characteristics: dominant and recessive. Tallness is a dominant—a sort of positive quality; dwarfness is a recessive—an absence. In breeding, the transmission of these characters follows what is known as Mendel's Law. When a dominant and a recessive character are crossed, say, a tall and a dwarf pea, all the first cross-bred generation possesses the dominant character of tallness, but the issue of these second generation cross-breds, if crossed again, will be 25 per cent pure dominant—tall; 25 per cent recessive—dwarf; and 50 per cent impure dominant—that is, tall which will not breed true tall again (see diagram).

Interbreeding of Types

If the dominants are crossed with the dominants, all their offspring will be dominant. If the recessives are crossed with the recessives, all will breed recessives; but interbreeding of the mixed impure dominants will again give the same percentage of 25 dominant, 25 recessive, and 50 mixed dominant.

It would seem that we have here a scientific basis for the improvement of the race by carefully schemed interbreeding of chosen types. And, indeed, if we were only seeking to breed people with one outstanding characteristic, such as red hair, green eyes or long fingers, we might attain our end. But as we have no possible knowledge of the hereditary make-up of any single individual, even so far as physical type is concerned, it is clear that a knowledge of Mendel's Law should make us more and not less sceptical as to the theories of the eugenists.

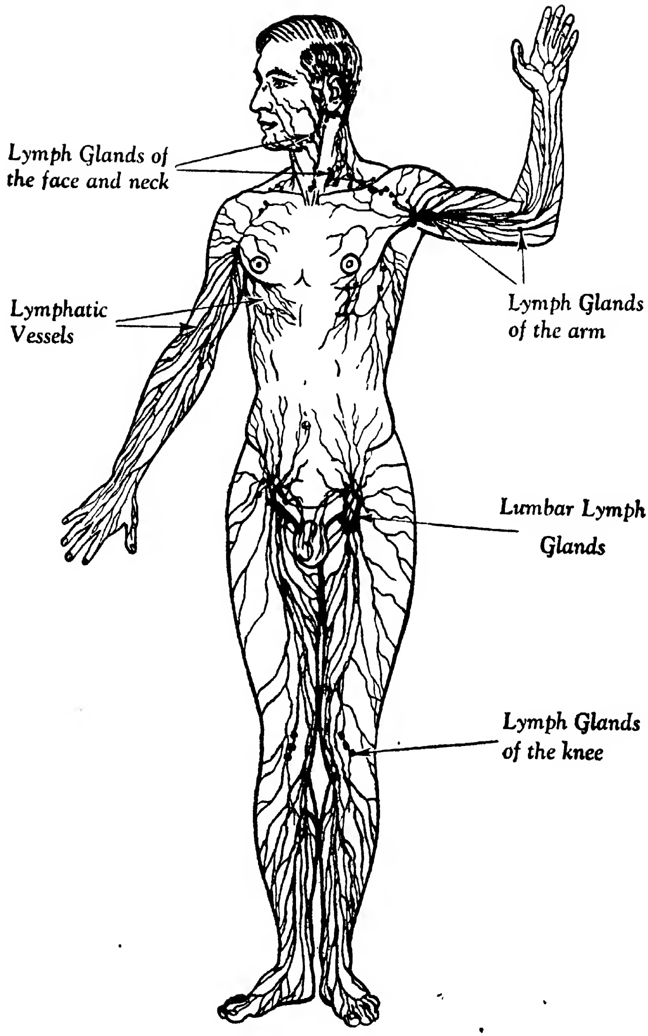
It should, moreover, encourage those sociologists who maintain that by education, care and love, a



EXPERIMENTS IN HEREDITY

Gregor Mendel, in investigating his theories on heredity, found that when a tall and a dwarf pea were mated, their offspring were all tall, but the second generation, if crossed again, were 25 per cent tall, 25 per cent dwarf. and 50 per cent tall which would not breed true tall again (third row of diagram).

child's character may be formed and—from the social point of view at least—improved; for any individual may have, lying dormant among his mixed inheritance of qualities, the potentiality of a genius, of a saint, or of a hero. The provision of a suitable soil may cause one of these dormant seeds to sprout and flourish.



LYMPHATIC GLANDS AND VESSELS

Lymphatic glands are found in groups, chiefly in the groin and armpit. The vessels carry lymph from all over the body to the large lymphatic ducts.

CHAPTER EIGHT

FUNCTIONS OF THE GLANDS

Lymphatic glands and vessels. How germs and bacteria are destroyed. Functions of the ductless glands. Thyroid and parathyroid glands. Glands of the pancreas which produce insulin. Work of the spleen. The two parts of the suprarenal gland. Glands responsible for sex characteristics. Pituitary gland in the brain and its secretions. How action of the glands affects conduct.

THERE are two kinds of glands in the body apart from those concerned with manufacturing digestive and other substances which are poured out on to some surface: either the interior of a tube or the skin. The remaining two groups are the lymphatic glands and the ductless glands.

If the term gland is used to mean a factory, where something is made, then the lymphatic glands are not glands at all. They may manufacture a few of the white blood cells of the body, but their function is far more that of a guard-house.

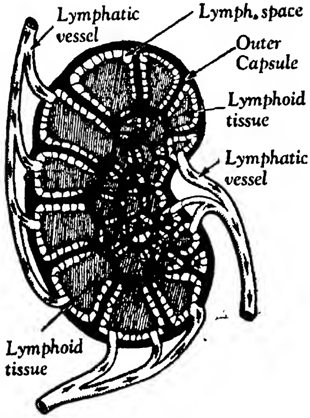
They are found all over the body, except within the brain case. They are connected by vessels which run with the blood-vessels and contain lymph, a fluid which has the same composition as blood, but contains no red cells and is therefore whitish or colourless. It contains white cells, though not in the same proportion as the blood does.

These lymph vessels form a dense network of interlacing canals under the skin, and the network is especially complex in areas where the skin is liable to damage and invaders may creep in to the deeper tissues. Eventually all the vessels conveying lymph empty back into the blood-vessel system.

The skin and the surrounding world is covered with bacteria, but the inside of the body, with the sole exception of the large intestine, contains none. Some of these bacteria are harmless, but a number of those which live on the skin can do damage to the body, and they creep in directly there is an opening, whether it be a cut or a scratch.

That is why the surgeon is most careful to kill all the bacteria on the skin before he makes his cut with a bacteria-free knife. Such a wound, offering an opening to very few, if any, bacteria, will heal quickly, leaving only a very fine and brief-lived scar. This is called healing by first intention.

If bacteria from the skin, or from the wounding implement, enter the tissues, there is at once great activity on the part of the surrounding blood and lymph vessels. Fluid oozes out from the microscopic vessels (blood and lymph capillaries) and this causes swelling of the wounded area. Then the blood-vessels running to the part are



SECTION OF LYMPH GLAND

Lymph vessels bring invading bacteria to the bean-shaped lymph glands, which contain in addition to lymph a number of white corpuscles. The latter eat the bacteria by enclosing them and slowly digesting them.

widened, so that a better supply of blood can be brought; this causes redness, and also the sensation of heat.

The pain nerves interfered with send their messages up to the brain to advise the voluntary muscles that it would be wise to rest this part, and they go into protective spasm. All these activities are reflex. Little is left to the intelligence —fortunately for us.

The white blood cells, which act as scavengers in the blood, distort themselves into odd shapes, so that they can squeeze through the tiny spaces between the cells of the capillary walls and rush to the rescue. The red blood cells cannot do this; but their function is to bring plenty of oxygen to the cells that are doing the first-aid work.

How White Cells Eat Bacteria

The fluid of the blood also carries a number of weapons of war which might be called poison gases, only that they are in solution: chemical substances which either kill the invading bacteria or else so change them that it is easier for the white cells to kill them. This the cells do by eating them—enclosing them inside their own cell walls and slowly digesting them, much as the amoeba ingests the particles which constitute its food. These white blood cells are more like the amoeba than any other body cells.

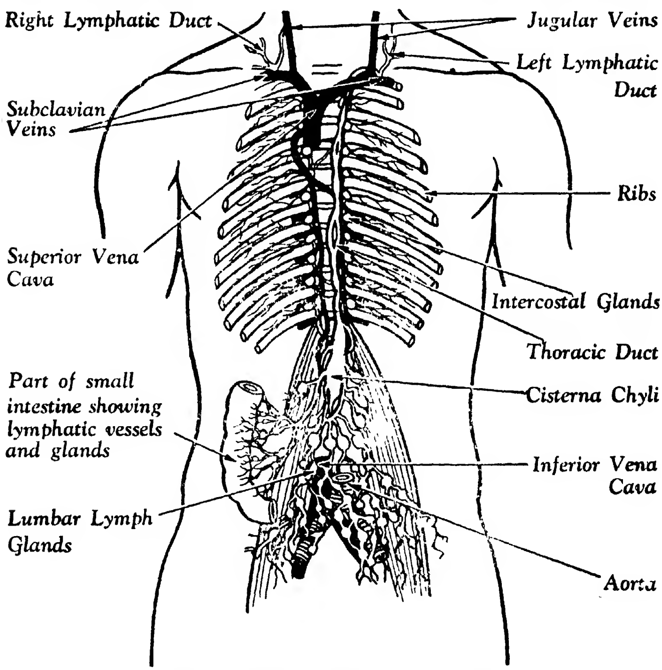
The fluid and the white cells, laden with their prey, particulate and chemical, enter the lymph channels, not the blood-vessels, and are thereby carried to the nearest lymph gland. Here there is a concentration of white cells ready to carry on the good work; so that if, by the time the flow from the wound gets there, the prisoners are as numerous or even stronger than the captors, the gland "guard" turn out and finish off the job.

If even they are overpowered, then the conflict is conveyed up the lymph channels to the next group of glands, and so on. Finally it reaches the blood, and then causes a general mobilization of the body's resources, generally heralded by a rise of temperature. Most simple wounds never get so far, but are

dealt with efficiently by the inflammatory process and the glands.

If there are many dead on the field of battle, pus is formed. This yellowish matter is the dead bodies of many millions of white cells. Sometimes the wound heals on the surface while the war is still not won. Then a collection of pus may form, causing an abscess; and, since these dead bodies are of no use to any one, and only make a heavy charge on other scavenger cells to remove them, it is better to let the pus out by opening the abscess.

Sometimes such an abscess occurs in the guard-house, or lymphatic gland; that indicates a more serious battle than pus just under the skin.



MAIN LYMPH VESSELS OF BODY

Most of the lymph vessels run to the main lymphatic duct, known as the thoracic duct, which begins in the abdomen as a large swelling called the cisterna chyli. The thoracic duct empties its contents into the left subclavian vein, while on the right the lymphatic vessels from the head and upper part of the body meet and enter the right subclavian vein.

The joining of serious battle in a wound (pus formation) is usually signalized by a sensation of throbbing, different from the pain of damaged nerve-endings.

The lymphatic glands deal with all kinds of diseases, as well as with wounds in the skin. The germs may get in through the digestive tract; or the trouble may be a cancerous growth, or infected tonsil: always the lymphatic glands of the area are involved and doing their best to stem the invasion. There are very few bacterial diseases or tumours which do not concern them.

Ductless Glands

The ductless glands are a group of factories which differ from the common glands of the body in that they pour their secretion directly into the veins which take away the used blood from them, and do not have ducts or canals which convey the stuff they manufacture direct to wherever it is going to be used.

Because they had no ducts they were for many years not recognized as factories at all. Yet they are far and away the most influential factories we have, and exercise a governing activity over all our most important activities.

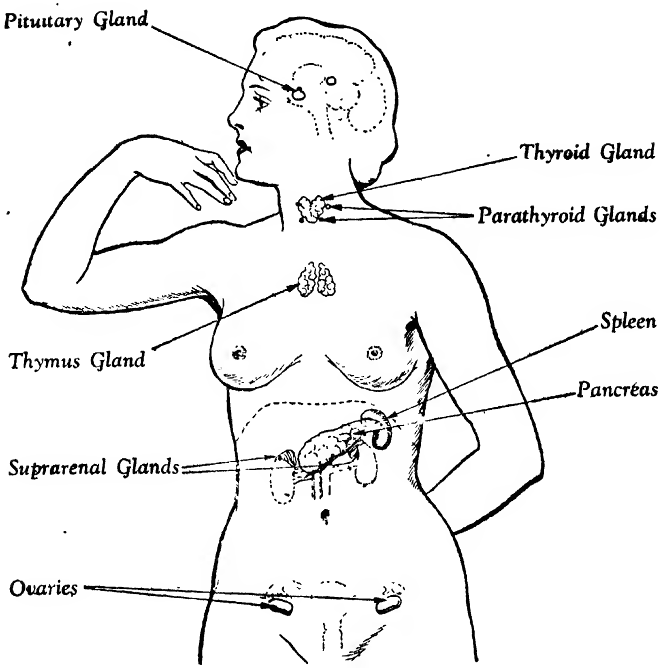
If the body be compared with an army, then the brain is G.H.Q. The staff has many contrivances for issuing orders and obtaining information, including the most up-to-date telephone system (the nerves), but may nevertheless find it convenient to use the ancient, primitive method of dispatch-riders.

In 1904 a British professor discovered that the pancreas (sweetbread) did not begin to work until it received a dispatch-rider message posted to it by the cells of the small intestine. There is no postal sorting system in the body, so letters cannot be addressed; they have to have their destination indicated by their molecular shape. They are like tiny keys which go on circulating round and round the blood system until they come to the only lock in the body which they will open. The professor called such dispatches hormones.

The glands of internal secretion, or ductless glands, are wholly devoted to manufacturing such keys or private dispatches and to sending them forth by the special messengers who carry them round the circulation until they reach their destination. All these glands together could be squeezed into a small pocket; they all have a rich blood supply, and plentiful nerve connexions with G.H.Q.—thus ensuring efficient communication.

Effects of Internal Secretions

All the messengers which carry their messages are very, very powerful; that is to say, the internal secretions act in minute doses. They are all quite harmless and the internal secretions do not evoke any ill effects; most of them resist boiling, but are destroyed by digestive juices. They produce, however, the most remarkable effects: they can determine the colour of the hair, the stature, the



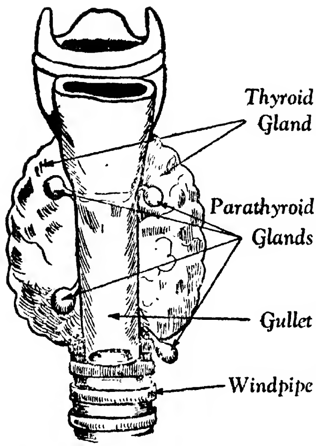
POSITION OF THE DUCTLESS GLANDS

The ductless glands are very important organs of the body and influence our activities to a great extent. The secretions they produce are called hormones, which are circulated in minute doses in the blood-vessels until they come to the part of the body for which they are intended. The above diagram shows the various positions in the body of these ductless glands.

growth of bone, the emotional and creative life, and other astonishing things.

One of the most important of these glands is the thyroid, which consists of two pyramidal halves lying on each side of the windpipe in the front of the neck, the two sides being joined by a thin band across the front of the windpipe. Under the microscope the thyroid consists of a framework of connective tissue enclosing round or oval hollow chambers which contain the special material, called thyroxin, which the gland produces.

This thyroxin contains iodine —all the iodine there is in the body,



THYROID AND PARATHYROIDS

The thyroid is an important gland, situated in the neck, which has a great influence on temperament. People deficient in its hormone, thyroxin, are dull and plump, while an excess makes people thin, highly-strung and restless. The parathyroids are concerned with maintaining the balance of lime salts in the body.

and only about fifteen milligrammes at that. It is nevertheless essential to life. Thyroxin is unusual in that it is not destroyed in the digestive tract, and so can be given as a medicament by mouth to people whose glands fail to manufacture it properly for them.

Thyroxin acts like a forced draught to the furnace of the body. If there is too much of it the fires flame high, and all body processes are speeded up. Therefore people become thin, restless, nervous, though perhaps highly creative. If there is too little of it, the furnaces burn dim, and people become dull, slow of speech, thought and movement; with dry coarse skin, falling hair; apathetic, plump in an unhealthy way, and "cabbage-like."

Within normal limits the thyroid is undoubtedly the gland of creativeness, and probably it played a large part in evolution. Tadpoles deprived of thyroid seldom, and then only very slowly, turn into frogs; those fed on extra thyroid become minute frogs long before their normal time.

When a factory is short of raw materials it is likely to turn some of its hands loose, but factories in the body do just the opposite: they take on more hands! In other words they increase the number of cells, and thus the total size, in an attempt to make up for the shortages.

Cause of Goitre

When there is too little iodine for the thyroid to manufacture into thyroxin, therefore, the gland enlarges, and this condition is known by various names, such as "Derbyshire neck," or simple goitre. Iodine comes to us only from the sea; therefore in the centres of countries the food grown is likely to be short of iodine, and so there is a deficiency in the diet.

This kind of goitre can be prevented altogether by adding a little trace of iodine to the diet, and this is usually done by mixing a salt of it with table salt, where it passes quite unnoticed. Simple goitres may also appear when the supply of

iodine is normal but the body is making special demands for thyroxin, as it does at puberty and during pregnancy, and sometimes they may appear when the body is struggling with an infection.

Defective Thyroid Gland

Sometimes the thyroid manufactures a thyroxin which has something wrong with it; this produces the condition called exophthalmic goitre, characterized by staring eyes, great nervousness, and some wasting. This condition is not clearly understood, but the only cure for it at present seems to be to cut down the factory space by removing a part of the gland surgically.

If an infant is born with a thyroid which does not do its job the child becomes a kind of mental defective called a cretin: he has pale, yellowish, harsh skin, straight, dry, sparse hair, a hoarse voice, a large protruding tongue and a subnormal temperature. He is late in learning to walk, dwarfed and dull, and can never look after himself.

This condition can be completely cured, if recognized early enough, by giving thyroid as a medicine. Sometimes the thyroid gland recovers and takes on the job after a few months or years; sometimes the cretin must take thyroid all his life if he is to be a normal individual and not relapse into a horrible Caliban-like idiocy.

Parathyroid Glands

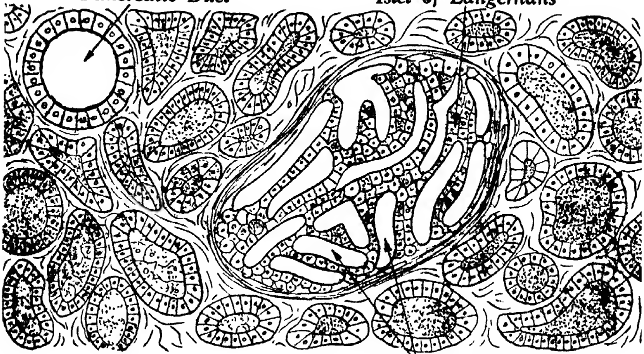
Behind the thyroid, often embedded in it, are four little pea-like glands, two on each side, called the parathyroids. These are concerned with maintaining a proper balance between certain elements in the blood, particularly the lime salts. How they do it is not yet known, but without them the lime cannot be properly laid down in the bones.

If the secretion is injected into normal people it causes a great increase in the lime of the blood. Probably it removes both lime and phosphorus from the bones and causes them to circulate. Without these little glands the body cannot live: it passes into convulsions; the nerves are over-excitable, and there are spasms, and a serious fall in the lime of the blood. Even if there is plenty of lime in the diet, it cannot be used without this hormone.

Thymus Gland in Infants

Behind the breastbone in infants there is quite a large gland called the thymus; this atrophies in older children and no trace of it is found in adults. Very little is known about it, but experiments have shown that in some way it governs development in the early days.

Various experiments have been made on rats, giving them thymus extract and comparing them with normal rats. The treated rats grew heavier and faster; their ears opened a day earlier, and their eyes a fortnight earlier; their teeth came through a week sooner; and they became hairy in two to three days instead of the normal twelve to sixteen.



SECTION OF PANCREAS

Among the pancreatic ducts concerned with digestive juices are clusters of different cells, known as Islets of Langerhans. These cells are ductless glands manufacturing insulin, which enables all the tissues of the body to burn sugar, and the muscles and liver to store it. Lack of insulin causes diabetes, which means that the body can neither use nor store sugar.

The pancreas as an ordinary gland, manufacturing a digestive juice, has been known for many years, but the discovery that it is also a ductless gland belongs to the twentieth century.

A certain scientist of Strasbourg had been experimenting on dogs by removing the pancreas. A physician walking across the courtyard where the dogs were exercised found that flies were collecting around the urine of some of the dogs and not of others. He inquired the difference between them, and learned that the pancreas had been removed from those whose urine attracted flies. He tested the urine and found that it was thick with sugar. Thus he first formulated a connexion between the pancreas and diabetes.

Scattered between the ordinary factory workshops which make the pancreatic juices are small clumps of different cells supplied by large twisted capillary blood-vessels. The work of two Canadians, Banting and Best, established the fact that these cells constitute a ductless gland (Islet of Langerhans) manufacturing a substance called insulin.

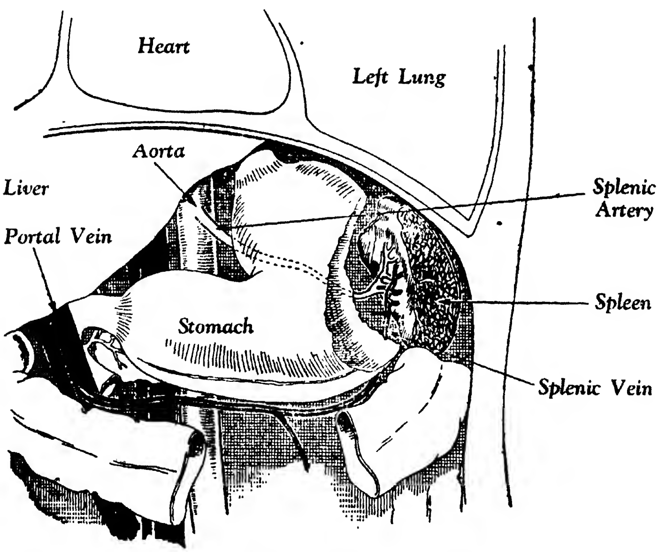
The failure of insulin causes diabetes, and now insulin can be given by injection to those whose pancreases fail to provide it for them, and so their lives can be saved and their diets made far more interesting. Insulin enables all the tissues of the body to burn sugar, and certain special tissues,

notably muscle and liver, to store sugar in the form of glycogen.

If it fails, the sugar circulates round the body, but the tissues can neither burn it nor store it, so the blood content remains much too high, and the kidney—whose duty it is to keep the blood-sugar down to the proper level—turns it out in the urine. The urine of the diabetic is therefore loaded with sugar. His tissues meanwhile are crying out for sugar, but it is no good giving it to them unless they are also given insulin to enable them to use it.

Situated near the pancreas, on the left side of the stomach, is the largest of the ductless glands, the spleen. This is about five inches long and is composed of lymphoid tissue, in which are embedded small white bodies (Malpighian corpuscles).

In the embryo the spleen is an important producer of new blood cells, but when this process is taken over by the bone marrow after birth, the function of the spleen is confined to the manufacture of some of the white blood cells, called lymphocytes, and the destruction



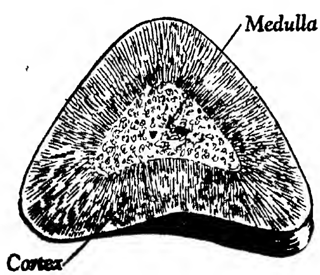
FUNCTIONS OF THE SPLEEN

The spleen manufactures some of the white blood cells, called lymphocytes, and it also destroys worn-out red blood cells. In addition to this it acts as a storehouse for red and white blood cells for emergency use when the sympathetic nervous system is in action and calls upon these reserves.

of worn-out red corpuscles. Reserves of both red and white blood cells are, however, stored in it for emergency use.

On top of each kidney is a curious conical-shaped body called the suprarenal or adrenal. When cut it is seen to consist of two different parts: the rind, or cortex, and the inside pulp, or medulla. Each of these is a ductless gland.

The medulla produces adrenalin, a hormone which raises all the organs to their highest state of efficiency. It is, in fact, a kind of adjuvant to the sympathetic nervous system, and is always produced in large quantities when that system is excited. It reinforces the action of the sympathetic nerves and continues working after the nervous stimulus has worn off.



SUPRARENAL GLAND

The suprarenal consists of two parts, each being a ductless gland. The inside pulp, or medulla, produces adrenalin, of which large quantities are poured out when the sympathetic nerves are in action. The outside, or cortex, is concerned with sex, and disease of this part often causes an unfortunate change of sex.

The effect of adrenalin, as of the sympathetic nervous system, is to increase the output of sugar from the glycogen stores in the liver, so that the muscles have plenty of fuel if they are needed for fight or flight; to make the heart work more energetically and raise the blood pressure, so that the brain, lungs, muscles and all essential tissues are supplied to the best possible extent with all they need; to widen the air tubes so that the lungs can get more oxygen into the blood; to make the spleen contract so that red blood cells and white blood cells are hurried into the circulation from the reserves, and to shut off the blood-vessel sluice-gates from the relatively unimportant organs, such as the skin and digestive tract, so that all the blood may be mobilized in the vital organs on which even life itself may depend.

Preparing Body for Action

At the same time, it prepares the eye to function at its maximum by lifting the upper lid, protruding the eyeball and dilating the pupil, and constricts the sphincters so that movement is not hampered by a desire to excrete. All these things are very useful and not unpleasant if the body at once proceeds to vigorous activity; they are most uncomfortable in confined spaces or when movement is severely restricted. Sometimes the muscles cannot resist the temptation to do something about it, even if they cannot move the body around, and it is then that we "shake with fear."

The adrenal cortex is a very curious hormone producer. Its function was first studied by seeing what happens when the cortex is diseased and so, presumably, not producing properly. In tuberculosis of the cortex, known as Addison's disease, the patient suffers from great fatigue and poor muscle tone; he becomes thin and flabby and suffers severely from the cold. The blood sugar falls and so do the body's stores of glycogen. All the symptoms can be cured by administering adrenal cortex taken from a suitable animal.

Effect of Salt Content

These patients are very susceptible to infections, and therefore some authorities think the cortex is concerned with resistance to disease. It seems to act by some control of the salt (sodium chloride) content of the body, and with the salt content goes also the fluid content, for it is essential that the fluids of the body should always be at a given concentration of saline. Patients with severe Addison's disease can be kept alive by giving them salt.

Most peculiar things happen when the cortex has a tumour in it; a growth, or overgrowth of cortex causes female bodies to show masculinity. If the disturbance is early —while the infant is still in the womb—the child may become a hermaphrodite; if later on in foetal life, the sexual organs of a female are enlarged and resemble those of the male.

After birth it makes the body of a girl approach the male type, with a deep voice and masculine distribution of body hair. A little girl may grow a beard, or a child of two have monthly periods! The child may be mentally retarded or physically stunted.

Changes in Sex

In women between eighteen and twenty-five such a tumour causes male distribution of hair and deep voice, with a general masculine outlook, though the changes are less marked than in the younger victim. A baby boy with an adrenal cortex tumour appears like an adult male and is called an "infant Hercules" because of his excessive muscular development.

The fact that such superficially extraordinary changes can take place in the body through over-activity or under-activity of this organ gives the clue to a good many everyday phenomena which puzzle some of us. Few are the people who cannot number among their acquaintances a masculine woman, whose tastes, habits and, often —though not always—appearance suggest the male rather than her own sex. No rarer are the feminine men; who are usually domesticated, artistic, interested in dress and furnishings, and often—though, again, not always — girlish in appearance.

When such inversion of sex goes a stage further, we get the unhappy individuals we call homosexuals, people who are cursed from birth

by their abnormality. Despised by the normal and regarded with suspicion by most, these unfortunates find that those emotions of love and passion which are looked upon as the highest form of human felicity are, in them, matters for shame and repression. Cut off from the natural expressions of these fundamental emotions, they must either live deprived of the finest part of human life, or express themselves in secret and in a perpetual conflict. Pity and sympathy, rather than contempt, should be shown to these sufferers by their more fortunate neighbours.

Secretions of Sex Glands

The hormone of the genital gland—testis in the male, ovary in the female—is responsible for producing the various changes in the body which show that the other part of the gland is functioning. Thus, it is prepared for the first time at the age of puberty. The internal secretion is produced by interstitial cells, while the reproductive cells are produced by the main part of the gland. In this way the genital gland resembles the pancreas, the reproductive cells taking the place of the external secretion, or digestive juice, produced by the principal cells of the pancreas.

The hormone produced by the testis is called testosterone. It maintains the health and activity of the various secreting glands which pour their product into the male genital passages. It also helps to keep the sex cells active, and it is responsible for the maintenance of what are called the secondary sex characteristics throughout the body. These include the growth of hair in the armpits, over the pubes, on the face, chest and big toe, and often elsewhere on the body surface.

Another secondary sex characteristic is the deeper male voice register, and the male shape of the body. If the testis is removed before puberty there will be no hair on the face or trunk and the voice will not break.

The female hormone, produced by the ovary, is called oestrin. This also is first manufactured at puberty and causes the changes which turn girl into woman: the development of the breasts and the distribution of fat to make the typical feminine curves, as well as the appearance of hair in the armpits and over the pubes. In addition, it acts on the internal genital system, setting up the monthly cycle which prepares the womb for the reception of a fertilized ovum.

Hormone of Pregnancy

Since this cycle must not continue during a pregnancy (for the monthly disturbance and bleeding would dislodge the ovum) there has to be another female hormone to stop the oestrin from acting during pregnancy. This is called progesterone, or the hormone of the corpus luteum. Corpus luteum means yellow body, and is so called because it looks yellowish when the ovary is cut across.

This hormone is not unlike some

of the constituents of bile in its chemical formula and, curiously enough, has been found in the vegetable kingdom, where it actually survives the tremendous changes which, during hundreds of years, change trees and plants into coal and peat. The hormone has been obtained from these fuels and from petroleum. It is very useful in encouraging the growth of plants; hyacinths and lilies of the valley which are grown in water or soil treated with this hormone flower more quickly and with better blooms than ordinary ones.

Its function in the woman is to hold up the monthly cycle and stop the monthly development of an ovum in the ovary; to maintain a pregnancy; and to develop the breasts for milk production. It makes the womb muscles slack and sluggish, so that they do not undergo contractions which might disturb the embryo, and it causes a great overgrowth of the spongy lining of the womb. This overgrowth makes the soft bed into which the fertilized ovum burrows.

This hormone makes a brief appearance and has an influence on the woman for a few days—less than a fortnight—in each month. Only if she is pregnant, however, does it come into its own, to take command for nine months.

Test of Pregnancy

The existence of these two hormones is responsible for the now familiar test for pregnancy. When the hormone of the pregnancy, corpus luteum, is in charge, the oestrin is not wanted in the body and is therefore passed out in the urine. If some of the urine of a pregnant woman is injected into young virgin mice, their reproductive processes (or puberty) are brought on before the proper time because of the activity of the oestrin in their bodies. If, therefore, these changes are found it can be said quite positively that the woman is pregnant.

Yet a third hormone is found in the female sex organs during pregnancy, and this is one which is produced by the placenta. It contains three parts, one of which resembles oestrin while the other two are like those of the pituitary: prolan A and prolan B.

Pituitary Gland

Hidden away in a pit at the base of the skull, underneath the brain, and some distance back from the root of the nose, is a pea-shaped body which hangs on a stalk from the base of the brain and is called the pituitary. This is the master gland of all ductless glands and its action is extremely complicated.

It consists of two parts, one of which is derived from the lining of the mouth while the other comes from the brain, and it is closely connected with the vital controlling centres at the base of the forebrain.

Its two parts produce quite distinct hormones. The front part produces internal secretions which control all the other ductless glands. One, the thyrotropic hormone,

stimulates the production of thyroxin by the thyroid; another, called the parathyrotropic hormone, encourages the parathyroid to get on with its work. Another boosts the adrenal, and a fourth is believed to have the same effect on the insulin factory in the pancreas.

The gonadotropic hormone, the one which acts on the genital gland, is divided into two, called prolan A and prolan B. Prolan A reinforces the action of oestrin: it stimulates the parts of the ovary which produce reproductive cells and hastens the onset of puberty. Under its influence the ovary awakes to activity and manufactures oestrin. Prolan B bears the same relation to the corpus luteum.

Effect of Pituitary on Growth

A very important hormone produced by the pituitary, and one which does not apparently act only through some other gland, but produces its effects directly, is the growth hormone. This is responsible for the proper growth of the skeleton, and when it is produced in excess before the bones have finished growing the result is a giant. (The record case is that of a Finn who reached the height of nine feet five inches!)

If the excess is produced after growth has stopped, a disease called acromegaly is caused. This is characterized by overgrowth of the bones of the face, hands and feet, and a thickening of the soft tissues, with enlargement of the organs. The result is a grotesque face with coarse features, negroid lips and greasy hair, and a steady increase in the size of gloves and shoes.

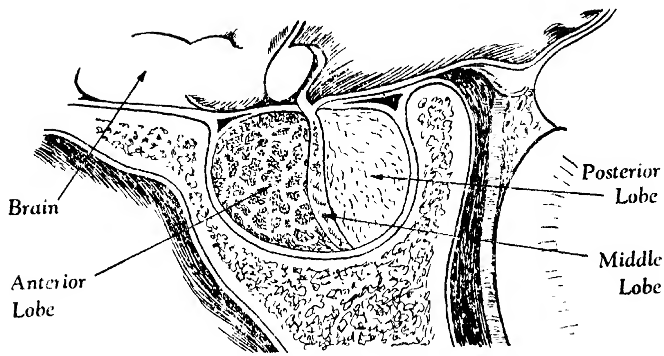
Cause of Dwarfs

If this hormone is inadequate the result is a mentally normal dwarf. There are, however, a number of varieties of dwarfs whose condition seems to be associated with failure of the front part of the pituitary. One kind is perfectly proportioned, delicately formed and quite pleasant to look at, with average intelligence and adult proportions—the true midget.

Another kind is a very fat dwarf with a voracious appetite and a slow sleepy manner; yet another is grotesquely fat and stunted but with slender hands and feet and often a curious mental streak, like the fat boy in Dickens's *Pickwick Papers*.

A further variety of dwarf inclines to premature senility; that is to say, he is like W. S. Gilbert's "Enfeebled old Dotard of Five": he may lose his hair and teeth and die of old age before he is ten.

The back half of the pituitary, that which is derived from brain tissue, makes a hormone called pituitrin, which contains three parts with different actions. The first, vasopressin, reduces the rate of the heart and shuts the sluice-gates in the tiny blood-vessels, which increases the general blood pressure. The second, anti-diuretin, reduces the flow of urine, and if it is lacking people suffer from a condition called diabetes insipidus, in which



PITUITARY GLAND

This is the master gland, for the front part (anterior lobe) produces internal secretions which control all the other ductless glands. The back part (posterior lobe) produces hormones which affect the urine, the amount of sugar in the blood, and the blood pressure. It also manufactures a hormone which causes the muscles of the pregnant womb to contract during labour.

they pass large quantities of pale watery urine.

The third, oxytocin, has a curious effect on the pregnant womb, causing its muscle to contract. Used in the right way by doctors, it is very helpful in slow or difficult labour. It has to some extent the same effect on unstriped or involuntary muscle wherever it is found in the body, for example, in the bladder, large intestine, and breast.

The back part of the pituitary also plays an important part in the use and storage of sugar in the body.

We have seen some effects of glandular disharmony, but there is another aspect to which we have not yet referred. All sorts of bodily derangements for which conventional medical science has not hitherto been able to account are now proved or suspected to be of emotional and glandular origin. An American physician, Dr. McLester, has estimated that one-third of the patients with disorders of the alimentary tracts—that is, the stomach, the intestines, and the organs of digestion generally—are suffering because of a lack of emotional balance.

In the evolution of man, whether by natural selection or otherwise, the postal system of communication between the several parts of the multicellular organism comes much earlier in animal history than does its partial replacement by the telegraph system which we nowadays possess and think mainly of as the controlling and regulating medium of our everyday activities

and of our thoughts—both conscious and unconscious.

Now, external things operate on both our instruments of intercommunication; that is, the postal and the telegraph—the chemical and the nervous. We get feelings and sensations such as touch, weight, sound, sight, taste and smell; we also get emotional reactions—fear, anger, love, hatred, jealousy, hunger, and so on.

Action Under Emotion

The word emotion signifies moving, and emotional excitement actually causes our muscles to move by directing energy and the food of energy to the tissues concerned. Under strong emotion, we all become restless, though our movements may not be directed to any purposeful end. The nature of the action was appropriate to the life we lived and to our environment at the time in our history when the impulses were evolved. They are often singularly inappropriate to the circumstances of today. Because of this, we do not obey the dictates of these old guides to action; we exercise self-restraint, self-control.

For example, a child to whom we are deeply attached dies. Our natural impulse would drive us to sob, to weep, to gesticulate—as some races, indeed, still do; but most of us, in these islands especially, control such signs of grief, with the result that we feel them more profoundly and more insistently, often very much to the detriment of our physical health.

We feel the emotion of anger; our inherent impulse is to strike and kill; consequently the blood is forced into the muscles of our heart and limbs and cut off from our digestive and other internal organs. Sugar is poured out into our blood with which these muscles may be fed for the fight.

But in our civilized state we do not often fight from anger, much more rarely do we kill because of it. Civilized man has progressed to the stage when he kills his fellow-men in cold blood for some abstract reason, often not fully understood. Hazlitt quoted Defoe as saying: "there were a hundred thousand stout country-fellows in his time ready to fight to the death against popery, without knowing whether popery was a man or a horse."

Emotion of Fear

A very similar series of physiological events occur when the emotion of fear causes our muscles to be charged with blood, and the blood with sugar, that our limbs may be in form for running away. But in these days we do not run away every time we are afraid; often with dire pathological results.

It is said that when there is a slump in Wall Street, New York (the American equivalent of our Stock Exchange), there is a great rise in diabetes and suspected diabetes incidence. What really happens is that the brokers and jobbers have a "fit of nerves"; their blood gets charged with sugar; the endocrine gland in the pancreas

which produces insulin is overworked, and the kidneys find themselves burdened with more sugar than they can dispose of.

Cases have also been adduced of persistent vomiting, one of which started "when an income tax collector threatened punishment if a discrepancy in the tax statement was not explained, and which ceased as soon as the physician himself went to the collector, as a therapeutic measure, and straightened out the difficulty."

Parallel or comparable cases by the hundred might be quoted. There is, for instance, a celebrated case of a fracture of the thigh bone which did not mend because of fear in the mind of the patient that his family was suffering because he was absent in hospital. This took away his appetite, which led to deficiency of nutrition, which in turn led to such impairment of the healing process that the bone fragments did not join together. Directly he heard that his family was well and happy, and being well cared for, he stopped worrying, ate heartily, and quickly regained his health.

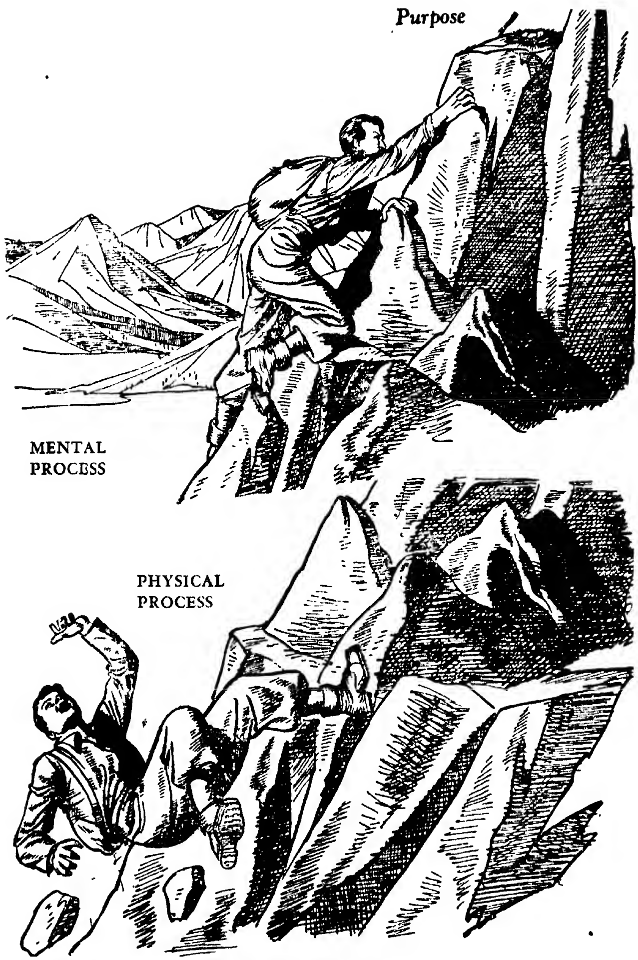
How Mind Affects Body

Here is one obverse case, associated with the thyroid gland. It is quoted in Cannon's work on *Bodily Changes in Pain, Hunger, Fear and Rage*. The case is that of a married woman who had seen her husband kill his two brothers. "The husband bitterly reproached her for not coming to his defence at the trial. A week after the trial a goitre became evident and reached a large size in seven days. When she came to the hospital a few months later, the goitre was huge, it pulsated visibly, had a palpable thrill and was causing an oppressive sense of suffocation. There was pronounced protrusion of the eyeballs, with marked tremor and restlessness."

Involuntary and Deliberate Action

All these phenomena point to the fact that there is a subtle connexion between what we call involuntary and what we call deliberate action; one sometimes even wonders whether there is any real distinction between the two processes at all. The whole problem of free-will and determinism is involved, and we soon find ourselves reasoning in a circle.

There is a similar relation between our emotions and our thoughts, between heredity, environment and personal liberty. Pieron, writing in 1928, described emotion as associated with a discharge of abnormally intensive nervous energy; and whilst he admitted that a part of this energy is applied to useful, adapted reactions—yielding increased strength and greater speed of running in case of need—he states that a larger or a smaller part of the energy is spent in useless facial contortions, and even finds its way into subtler parts of the organism where harmful and dangerous processes may be set going. In this way, great emotional disturbances have been known to cause death.



MIND IS PURPOSIVE

Mental activity is directed by a purpose; physical activity (unless directed by the mind) is involuntary. This great difference between the two processes is illustrated by the climber, who, in striving to reach the nest, symbolizes purposive activity (mental process). A fall of rock causes him to lose his footing and he cannot save himself, thus symbolizing a purely physical process.

PART 2 HOW YOUR MIND WORKS

CHAPTER NINE

MIND AND INSTINCT

Observing mental processes. How mind and body influence each other. Purpose the main characteristic of mind. Consciousness and the self. Factors comprising personality. The instinctive impulses. Nature of emotion. Modification of the instincts. Theory of Behaviourists. The child mind.

PART 1 of this book reminds us that the body is "fearfully and wonderfully made." In this part we are to consider mind, even more wonderful, and try to answer the question: How does the mind work? In so doing we are following some very old and very good advice: "Know thyself."

Our knowledge of ourselves lags very slowly behind our rapidly increasing knowledge of physical things; and civilization runs grave risks because mankind is unfit to be trusted with some of the discoveries of the physical scientist. In fact it was seriously suggested a few years ago that, in order to avert catastrophe to our civilization, physical scientists should forget atoms, chemicals and machines for, say, fifty years and apply their energies to human problems.

Although this suggestion is impracticable, psychological questions are certainly of urgent importance, and must not be overlooked in future world planning.

The psychologist studies scientifically the behaviour of human beings, as individuals and as members of a group. He tries to avoid bias and prejudice. This is difficult, especially where he has a strong personal interest.

The scientist systematically endeavours to find out how things work; and in so doing he observes, describes, analyses, classifies, generalizes and experiments. Psychologists, in their scientific inquiry into behaviour, study, for example, sensations, feelings, thoughts, desires, habits, memory, judgment, instinct, intelligence and character.

First, then, the psychologist observes and describes mental processes. Accurate observation is difficult, as the observations even of a scientist tend to be influenced

not only by his degree of physical efficiency, and his powers of concentration, but by his emotions, his interests, his aims, his prejudices. The more personally interested the observer is in the object observed, the more difficult it is to observe exactly, for there is wishful observation as well as the wishful thinking against which we are so often warned.

In psychology, observation is especially difficult, as the mere fact that a process is being observed often changes it. If a man knows that I am looking at him, his behaviour will almost certainly be different from his behaviour when he thinks he is unobserved. The same change occurs when we observe our own mental processes. If, for example, when enjoying music we pay attention to our enjoyment rather than to the music itself, we lessen that enjoyment.

Analysis and Synthesis

After observation and description come analysis and synthesis. In analysis material is split up into its constituents; in synthesis the opposite occurs, constituents are built up into a structure. The chemist analyses, let us say, washing soda into sodium, carbon and oxygen. The psychologist analyses (always remembering that the whole is greater than the mere sum of the parts) mental processes.

Thus, a feeling in a strange situation may be analysed into the elements of curiosity and fear; or admiration, into wonder and self-abasement; the memory process, into committing to memory, retention, recall and recognition.

Synthesis is putting together. The chemist produces synthetic rubber built up from its elements in the laboratory. The physician in treating a nervous breakdown first analyses and lays bare the repressed impulses. He then helps the patient to effect a synthesis of the originally conflicting elements into a unified personality. The repressed instinctive energy, which fought against the will, is now brought into harmony with it. In other words, the aim of all mental healers is to make the patient whole.

Classification of Mind Elements

The facts discovered by the psychologist by using the foregoing methods are placed in various classes according to the scheme he has in mind. He would, for example, divide the following into three classes: reasoning, judgment, planning, anger, fear, wonder, striving, desire, perseverance. He would place the first three into one class—they have to do with the intellect, the head. The second group of three are feelings—they concern the heart. The third group are matters of the will.

The results of an investigation may suggest that they are connected by a fixed law: an attempt is then made to make a generalization, that is, a general statement expressing that law. For example, information may have been obtained as to the intelligence of a

group of people; and also as to their powers of memorizing. We generalize (in other words, make a more or less reasonable guess) that good intelligence correlates with a good memory.

This law must be tested by experiment, which leads us to the next method of science in which results are produced under controlled conditions. We thus test our law, by measuring the intelligence and powers of memorizing of a large number of people. Results being inconclusive, a further series of experiments on the memory process is necessary.

Ultimately it is shown that there are two kinds of memorizing: by rote, a mere learning parrot fashion, which does not correlate with intelligence; or by observing logical relationships in the material to be memorized, which does.

Connexion between Body and Mind

There is obviously a very close connexion between body and mind. Indigestion makes us gloomy, and gloom causes indigestion; or a more pleasant example is when the thought of roast beef and baked potatoes makes the mouth water.

Remarkable examples of the effects of mind on body are provided by hypnosis. Burn blisters have been produced merely by touching hypnotized subjects with a black lead pencil after they had been told they were to be touched with a red hot iron. It is a curious fact that these blisters take longer to heal than ordinary burn blisters.

Body affects mind when a heavy supper provokes bad dreams, or a drug induces visions of ecstasy. Certain diseases produce in the patient toxins which have mental effects. Sometimes such toxins even induce a quite unwarranted state of cheerfulness and optimism regarding his chances of recovery.

Differences between Body and Mind

Mind and body are essentially different. Our bodies can be weighed, measured or broken like any other piece of matter; but how can a thought, an inspiration, be weighed, measured or broken? A room uncomfortably crowded with people does not become more crowded if they all start thinking vigorously. Mind and body follow different laws: those of the body are ultimately the laws of chemistry and physics; the mind's laws are obscure, and in fact mind often seems not to be beholden to any law at all when exercising freedom of choice in acting or not acting.

These essential differences between mind and body lead to the question: How can mind and body influence each other? Many theories have been put forward as answers to this question.

One answer suggests that they never really come together at all, but that they run on parallel lines without influencing each other. They are like two clocks back to back, perfectly synchronized and both continuing to tell exactly the same time, but without being in any way connected with each other.

In another answer to the question mind and body are likened not to two separate clocks, but to two clock faces with one set of works. Mind and body, the two clock faces, are two aspects or appearances of the same thing, the works. We may ask what is this same thing which from one point of view appears as mind, and from another point of view appears as body; which appears to me as my thinking and would appear to you (if you could see into the molecular structure of my brain) as agitation of particles? Of this same thing, this neutral stuff which is neither body nor mind, we are told nothing, as we are told nothing of the mysterious agency which keeps the two identical clocks perfectly synchronized in the first theory.

Practical View of Body and Mind

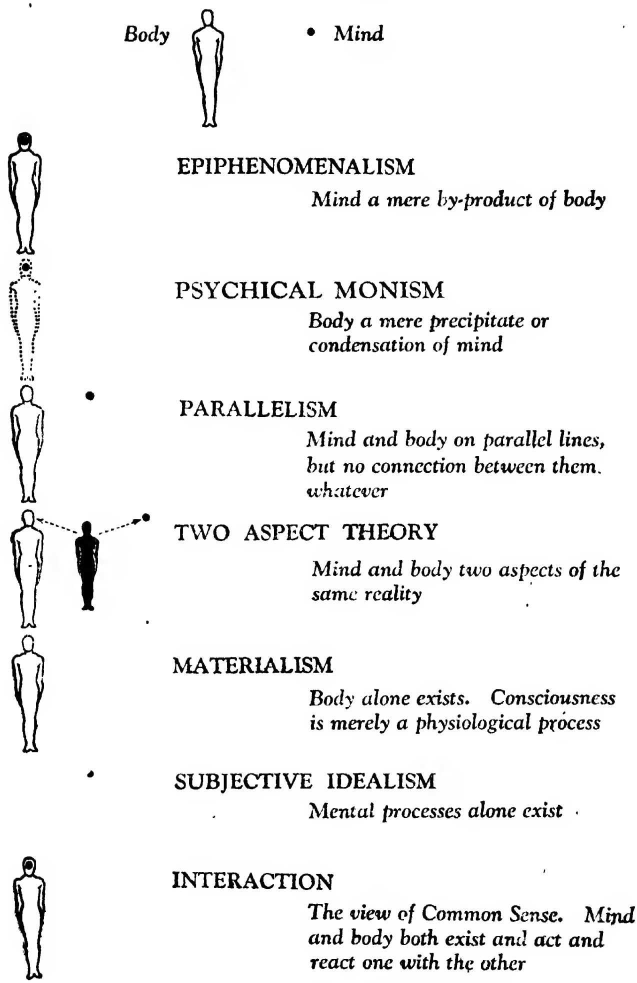
There is one view of our problem which in practice must be adopted as a basis for behaviour, whatever theoretical view one holds. This practical view is the view of common sense that, however far we go in explaining physical processes, there is a mind or soul also: a spiritual something quite different from the body but which interacts with it. Body can affect mind: mind can affect body—how is a mystery—and although they interact, they can also act independently. They are not inevitably connected like two clocks identical in timing, or like two clock faces with the same works. Mind interacts with body, uses it as its instrument, but in a very real sense mind can be untrammelled by the physical.

The physical scientist, as a result of his researches into the nature of matter, has been forced to admit that underneath matter is mind. In psychology, strangely enough, the primacy of mind still needs to be stressed. It is often said that man has a mind; it is more accurate to say man is a mind and has a body.

Mind is Purposive

Mental activity differs from all other activity in being directed by a purpose. Let us compare such purposive activity with, say, the movement of iron filings under the attraction of a magnet. They jump to join it, and even if a card has been placed over the poles of the magnet they are still attracted, although separated from the magnet by the card. They remain pressing on it but never try to make their way round it to the magnet. The filings have no mind.

Consider another kind of attraction: that between Romeo and Juliet. They desire to meet, but a high wall separates them. They do not stand idiotically pressing against it. Romeo tries to go round it; if this is impossible he tries to climb it; he may have to search for a ladder. If one method fails, he tries another. In other words, his actions serve a purpose. His mind is working. The filings are attracted in a fixed direction but a chance obstacle effectively prevents them reaching their end, the magnet. Romeo's direction is not fixed, there



RELATION BETWEEN BODY AND MIND

Obviously mind and body influence each other to a very great extent, and many theories have been put forward to explain how they are related. Some of the most important of these theories are illustrated in diagram form above.

is a number of paths he can follow. He chooses the quickest possible.

This, then, is the main characteristic of mind: purpose. Mind has an end in view and chooses means to attain it. Mental processes seek a goal in front; physical processes are pushed on from behind.

Purpose is not merely foresight of the result of an action. A motorist, who has lost control of his car, foresees a crash, but the crash is hardly his purpose. In purpose there is, besides foresight, the desire that the result shall be achieved, and steps are taken to bring about the result. A motorist's purpose is to reach his destination, and he takes all necessary measures, including driving carefully, to achieve his end.

Activity may be purposive although the purpose is not clearly seen. Our bodily welfare, for example, is furthered by a number of unconscious activities involved in such processes as nutrition, growth and repair of injuries.

Instinctive Activity

On the instinctive level, our activity is directed towards great biological ends, for example, self-preservation, reproduction, care of the young. These ends may or may not be clearly seen at the time of the action. The mother sacrifices herself for her child because it is her child. She may be only dimly aware of the larger end that her conduct is furthering: the preservation of the race.

On the higher level of deliberate willing and choice, when decisions are made to advance some plan, the purpose is clearly seen. Purposeful activity at its highest level involves, therefore, a clear consciousness of the end in view.

Consciousness and the Self

We all know the meaning of consciousness but none of us can explain it or define it. The most ignorant man knows what you mean when you tell him that he was unconscious after a blow on the head. Consciousness is one of those things of which we can obtain knowledge only by experience. Attempted explanations are meaningless unless we already know what is being described.

If when thinking we introspect, that is, look within, we become aware not only of our thoughts but of the living and active self which is doing the thinking. We are aware not only of the flaming colours of a beautiful sunset but of the self which enjoys its glory. We are aware not only of the harmonies of a Beethoven symphony but of the "me" listening.

How it is that we can look at ourselves, that the self can be both subject and object, is quite inexplicable. The fact remains that by insight we become aware of a living and active self.

Psychologists in the past, by methods of analysis which were too persistent, seemed to lose sight of the self by becoming involved in a kind of mental chemistry, a bricks and mortar psychology. In this, separate elements of mental life

were studied and the important principle, that the whole is greater than the sum of the parts, was forgotten. The mistake was made of starting from the outside. Separate faculties such as sensation, perception, conception, memory, judgment, thought, desire, were regarded as so many distinct elements and it was overlooked that they are the activities of a unified self.

Laws of Association

Attempts were made to explain all mental process by means of the laws of association, whereby one idea automatically gave rise to another, leaving little or no place for an active and directing self. These laws were four in number:

1. Association by contiguity in space. Thus, to think of a thing reminds us of another thing near to it. If I think of the Houses of Parliament I am reminded of the River Thames.

2. Association by contiguity in time. I think of the year 1066 and the idea Norman Conquest is at once called to mind.

3. Association by similarity. The thought of the Atlantic Ocean calls up the thought of the Pacific Ocean.

4. Association by contrast. A dwarf may call to mind a giant; a restricted wartime meal a pre-war feast.

In the early nineteenth century these laws dominated psychology; and the merely mechanical explanation they provided of mental processes left no place for the self or personality.

Many modern psychologists repudiate this old view and believe in a self-determining personality which acts with purpose. From this starting point we are led to a worth-while study of the mind and its workings.

The many activities of the self have, since very early times, been placed under three headings, sometimes called the three elements of mind. These headings are knowing, feeling and willing.

The technical term for knowing is cognition, in which our head is used. Feeling, in which our heart is concerned, is described by the word affection, which has not its usual meaning of love, but covers all experiences, pleasant and unpleasant, involving feeling, desire and emotion. The third element, willing, or conation, includes all our mental states which involve the process of striving, or exercising will.

Strictly speaking, all three of these elements are in every mental process. In trying to solve a mathematical problem, it might be thought that only the element of knowing is involved, but there is also a striving to solve the problem. How is feeling involved in the solution of a mathematical problem? We feel pleased or displeased at success or failure in our quest.

The mistake must be avoided of assuming that we have divided the mind into three organs or parts; we must remember that cognition, affection and conation are three phases of one mental process.

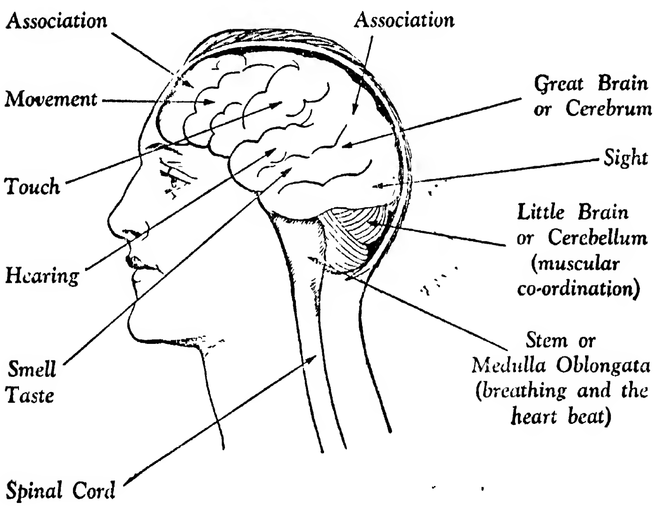
The warning against regarding the mind as split into parts is very necessary as we study certain mental processes. These processes include sensation, perception, imagination, memorizing, impulses, strivings, reasoning and volition.

We shall also consider various factors, the sum total of which comprises our personality, that something which distinguishes us from other people. These factors are temperament, instinct, intelligence, character and will; and we do not ignore the most powerful influence of all on character and conduct, namely, the ideal, a something outside the self.

A sensation is aroused in us by a stimulus and, as we saw in Chapter Six, is an activity first of those organs we call the sense (or receiving) organs, then of the sensory nerves joining those organs to the brain: and then of the sensory centres in the brain.

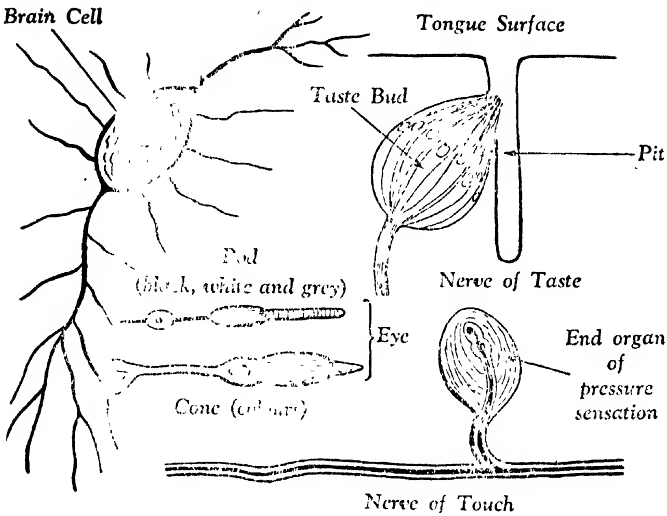
When we say, therefore, that we have eyes in the back of our heads we are really speaking the truth, since without activity in the visual centres in the back part of the brain we would not be able to see. Light waves falling on the retina are the stimulus giving rise to the sensation of seeing. Sound waves impinging on the ear drum are the stimulus of hearing. Similarly the other sense organs are stimulated.

Attempts have been made to ascertain the elementary sensations



CONTROL CENTRES OF BRAIN

Bodily functions are controlled by centres in the brain, and the various sensory and motor centres of the brain are indicated in the above diagram.



NERVE CELLS OF SENSE ORGANS

Sensations are conveyed to the brain through the various nerve cells of the sense, or receiving, organs. Above are some of these nerve cells, highly magnified.

of which most of our sensations are blends of greater or lesser complexity. Visual sensations have thus been analysed into the six elementary sensations of white and black, yellow and blue, red and green; sound sensations into noise and tone; touch sensations into pressure, warmth, cold and pain; taste sensations into sweet, bitter, acid and salt; and the sensations of smell into spicy, flowery, fruity, resinous, foul and scorched.

In addition to these, we have organic sensations such as hunger, thirst, nausea, suffocation, and senses of bodily movement, which enable us to preserve equilibrium and control muscular movements.

Sensation is, therefore, the first conscious response to a stimulus. Perception is the second response: a response to the sensation. In other words, we perceive when we recognize the object which is arousing the sensation.

Pure sensation, without any recognition, can scarcely ever occur in an adult; perhaps it occurs occasionally on sudden awakening from sleep, when a something in the room may be seen without it at once being recognized. If an orange is held before the open eyes of a very young child he sees, but he does not see an orange. Not till

later will he have the experience of sensation plus recognition, and thus perceive the orange.

In perception we bring our past experience to bear on a sensation. We look out of the window and say that the road looks wet. Wetness, of course, is not something seen but something felt; but we know that wet roads we have seen in the past looked like this one. Similarly, we may say that an aeroplane is passing over, although we may not even trouble to look up; but we hear the sound of the engine and perceive an aeroplane.

Imagination and Memorizing

In sensation and perception we are thinking of an object which is actually present. In imagination we think of absent objects. This is a remarkable feat; it is quite inexplicable and only its frequency makes it appear commonplace. In imagination we manipulate facts derived from our past experience. We re-arrange them and may produce a result we have never before perceived. Thus imagination produces a centaur, composed of a man and a horse, or a mermaid composed of a woman and a fish.

In memorizing we distinguish four processes: learning, or committing to memory, retention, recall and recognition. Many methods are used in committing material to memory, and the better these methods are, the longer the material learned will be retained.

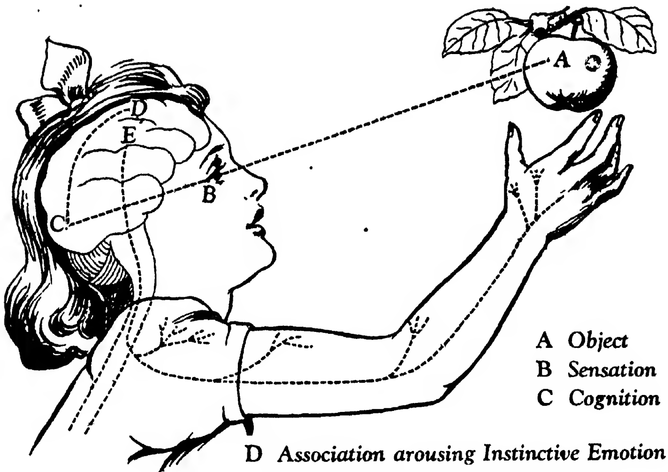
Retention alone is not enough because if the material cannot be recalled it is useless. Thus we sometimes know that we have retained, say, a man's name, but we cannot recall it. "It's on the tip of my tongue," we say. When material is recalled, it must be recognized as the material we committed to memory. Sometimes we recall an item without recognizing it, as when we recall a person's face but are unable to recognize who he is.

Instinctive Impulses

Consciousness demands activity, and this activity of the dynamic self is one example of the ever-changing activity in which every living organism constantly seeks to express itself. The activity may be physical as well as mental, or it may be purely mental. The mind of a man sitting quietly in an arm-chair may be a hive of activity. We are so made that we cannot remain inactive even though there is no call at the moment to act in pursuit of a particular end.

This urge to action may explain the interesting activity we call play. Pure play is activity for its own sake and should not be confused with a game in which the self-assertive impulse, shown in the desire to win, complicates the play impulse.

It has been suggested that the first activity of the unborn child consists of movements to avoid discomfort, If this is a correct explanation of our prenatal activities, they are typical of many later actions in which avoidance of pain, of which discomfort is a mild



HOW THE INSTINCTS WORK

This diagram illustrates how an instinct is aroused by an outside stimulus. Cognition of the object through sensation leads to the association arousing the instinctive emotion, which in turn motivates the impulse to act.

form, is an important source of our motives to action.

Many actions arise from the urge to avoid the discomfort of unsatisfied appetites. The distinctive feature of an appetite is that it occurs again and again. Hunger may be fully appeased, but we know that, if in health, we shall have a good appetite for the next meal. The appetites are inherited and are for food, drink, air, sleep, rest, physical exercise, excretion, sex. These occur again and again because there is a continual repetition of certain vital body processes.

On the other hand an instinct, also inherited, is stimulated not from within the body but by an external stimulus (including a stimulus imagined). This stimulus does not occur periodically, but occasionally. Further, an appetite may be satisfied by a changed physical state, but an instinct demands a changed psychological state.

Thus, without much thought on our part, our appetite for sleep is stimulated daily at our usual bedtime, and is satisfied when the body is refreshed. On the other hand, our instinct of self-preservation is stimulated whenever we are aware of danger. All our mental and physical powers are aroused. When the danger is averted our satisfaction is

not merely physical—great mental relief is also experienced.

When in ordinary speech we say "I did that by instinct," we mean "I did the right thing without thinking." We need, however, to use the word more exactly. Instinctive behaviour is native, that is, unlearned. Our instincts are part of our inherited make-up. Sometimes we talk of instinct in the lower creation when probably the phrase "behaviour mechanism" would be more accurate.

Behaviour Mechanisms

Many fascinating examples could be given, but two must suffice. Eels in European rivers, when they reach the age of ten years or more, migrate down to the sea, and swim across the Atlantic to West Indian waters where they spawn and die. All eels from European fresh waters make this journey before they breed. They have never been shown the way. Later, the young elvers, their offspring, make their way slowly back from the West Indies to the European rivers.

The worker bee has a whole series of instincts (or behaviour mechanisms). When hatched, she emerges from the pupa skin, dries and cleans herself, and then cleans out the wax cell in which she spent her youth as grub and pupa. In three days the worker begins the difficult task of feeding the grubs in the cells. A few days later she sucks up nectar from the mouths of the older workers on their return to the hive. In the worker's body the nectar changes into honey. She then squirts it into special storage cells in the comb. Later, she takes pollen brought home by the older workers and stores that too.

A day or two later she acts as a dustman and carries dirt out of the hive. Then she produces wax from her body and with it builds cells in the comb. These cells provide the maximum storage capacity from any given quantity of wax, a capacity in calculating which we might require the integral calculus! This task complete, she acts as a guardian at the door of the hive and stings any intruding bees. Lastly, on the twentieth day of her age, she starts flying out of the hive to collect nectar and pollen.

The bee does these tasks in a fixed order. The tasks would demand intelligence, knowledge and the acquisition of great skill if they had to be learned.

Inherited Memory

These behaviour mechanisms fit the old definition of instinct as the faculty of acting in such a way as to produce certain ends without foresight of the ends and without previous education in the performance. The eels and the bees when acting as they did had no knowledge, we assume, of the great end they were serving, namely, the preservation of their species. They had no opportunity of learning the complicated activities, for they were unhatched eggs at the time of the previous performance. In fact, instinct has been defined as

inherited memory. Each has a personal and a private memory as well as a distinct racial memory.

Instinctive Responses

The important difference between the instincts or behaviour mechanisms of the lower creation and instincts as shown in human behaviour is in the part played by cognition. Before the importance of instinct in human behaviour was recognized, it was generally agreed that animals are guided by instinct and man by reason. This seems a boastful comparison, but it is true nevertheless that in behaving instinctively man intelligently examines the stimulus to a much greater extent than do the animals in their blinder, more automatic responses. The instinctive response on the higher levels is to the meaning of the situation. A falling beam, a charging bull, a collapsing bridge, although very different, have all the same meaning—danger to be avoided—and the instinct to escape is immediately aroused.

On the other hand, the response in many behaviour mechanisms is blind. A certain wasp lays her egg inside a paper bag and places food outside. The grub on hatching out instinctively bores through the paper and eats the food. If an interfering naturalist places the bag containing the egg inside another bag of the same substance as the first, and puts the food outside this second bag, the grub will starve to death. It bores through the first bag, but this exhausts its impulse to bore, although food is just outside the outer bag.

McDougall illustrates an inherited danger instinct by his own experience in the zoological garden at Calcutta when he stood before a cage containing a huge, recently captured, Bengal tiger. A sweeper had amused himself by teasing the monster and every time he came near the cage the tiger rushed forward with an awful roar.

McDougall says that on each of the many occasions this happened a shudder of fear passed over him and he had to make an effort to stop himself running away. Although he knew the bars would prevent the animal's escape, the emotion of fear and the impulse to run away were aroused by his perception of the tiger.

This example is interesting, as it shows that the emotion of fear is aroused immediately the dangerous object is perceived, even if a barrier prevents real danger.

Emotional Factor

One definition of instinct is that it is the meaning of the situation which evokes the instinct. There is not a blind response to a particular object. A barking dog may mean the same to a rabbit which has been hunted before as does a silent man with a gun. Birds which have occasionally been shot at will sometimes not take flight at the sight of a man with a stick until he points the stick at them

McDougall emphasizes the emotional aspect of the instinctive

impulse. This is the constant factor. Many different situations may arouse any given instinct and there will be many different responses, but in all the feeling experienced is the same.

Two or more primary emotions blend to form complex emotions. Gratitude thus consists of tender emotion and negative self-feeling. Scorn comprises anger and disgust, possibly positive self-feeling as well. Hate is a blend of fear and anger.

Effects of Fear

Emotion has been well defined as stirred-up-ness. (The word emotion comes from a Latin word for movement.) Under stress, say, of fear, the body is certainly stirred up. We tremble, the face becomes livid and contorted; the adrenal glands send adrenalin into the blood stream, causing the beat of the heart and the rate of respiration to be accelerated; digestion is stopped. We may experience goose flesh; our hair may stand on end. Extreme terror has even been known to cause death.

An emotion does not always involve violent bodily disturbance but there are always sensations, of greater or lesser intensity, arising from the internal organs, the muscles and the skin. An impulse is emotional to the extent that it arouses such sensations.

Different answers, which are not so much contradictory as complementary, have been given to the question: "What is emotion?"

A theory advanced independently by James, the American, and Lange, the Dane, states that emotions consist of the complex of sensations caused by bodily movements, internal and external, resulting from the perception of the exciting object. An emotion is thus our awareness of the bodily changes caused directly by such perception.

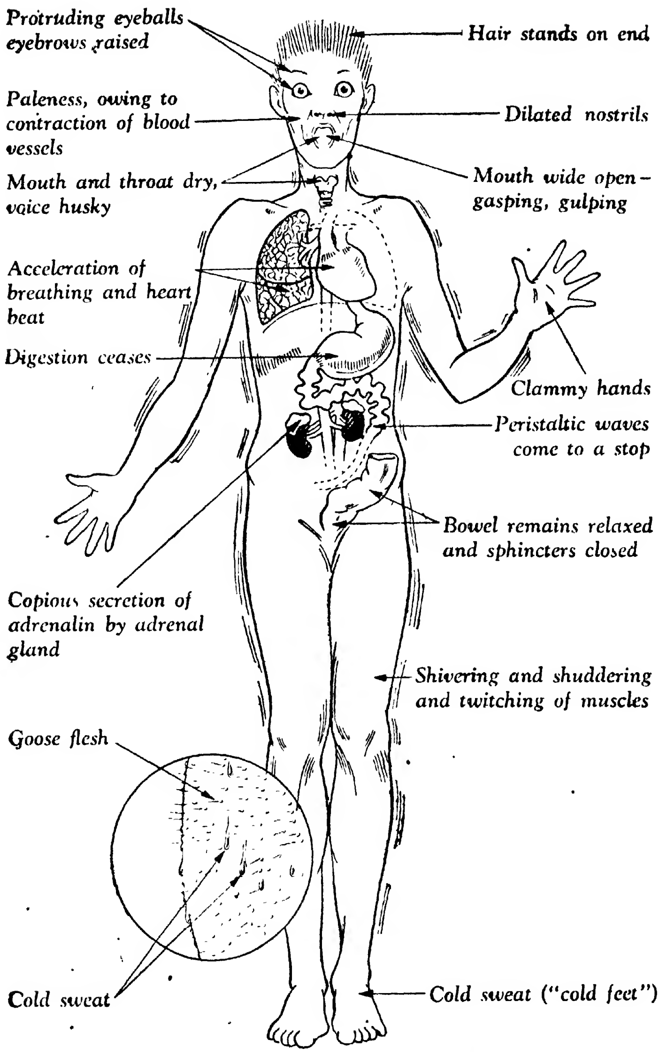
We perceive a dangerous object and as a direct result of that perception, certain bodily changes take place. We become aware of these changes and then feel afraid. It follows, therefore, that we are afraid because we tremble, not that we tremble because we are afraid; we are distressed because we shed tears, not that we shed tears because we are distressed.

When this theory is tested, it is found to be less absurd than it first appears. Who, for example, has not whistled to keep his courage up? If we determine to look happy, confident or gloomy we will probably feel happy, confident or gloomy. If a speaker trembles before an audience, he gains confidence if he grasps a substantial piece of furniture and stops his trembling. Actors feel, in some degree, the emotions they portray.

Feeling by Simulation

These instances suggest that we can feel an emotion if we deliberately copy the bodily expression of that emotion. The following example is very illuminating.

A doctor warned the wife of a patient, gravely ill, that she must put on a cheerful attitude to prevent



PHYSICAL EFFECTS OF FEAR

him reading in her face the gravity of his condition. She accordingly put the corners of her mouth up, and not down, kept a bright look in her eye and even hummed a tune. She thus gave the outward appearance of being cheerful. She found that she actually felt cheerful and reproached herself bitterly for being disloyal to her husband.

Fear Aroused by Suggestion

There is, however, physiological evidence against the theory. When fear is aroused, adrenalin in the blood causes the sensations in the internal organs which are said by the theory to compose fear. If, however, adrenalin is injected into the blood, although it produces these sensations, the individual does not feel afraid unless the idea of fear has been supplied by suggestion. (Note that in the other examples given the idea of confidence, or gloom, or cheerfulness, was in the mind at the outset.)

McDougall's theory holds, as we have seen, that the emotion is one aspect of the consciousness accompanying instinctive behaviour. A suggested modification of the theory is that the emotion is felt only when an instinct or appetite is thwarted. In support of this we are reminded that if escape from danger is hindered, fear increases; if the escape is unhindered, fear lessens or disappears. If this version were true in general, an impulse, if given free rein, and not thwarted at all, would be accompanied by weakened emotion; this is manifestly not the case, as lack of restraint of, for example, the sex impulse, strengthens, not weakens, the emotion.

A third theory, known as the boiling-over theory, suggests that emotion arises when nervous energy goes to waste, when there is no systematic use for it. During emotion we certainly expend energy, emotion takes it out of us; and probably we should live longer if we lived without emotion. It might be replied that such a life would not be worth living.

As a guide to conduct, McDougall's theory is by far the most useful. An emotion, being the central core of an instinctive impulse, is the same whatever the situation may be in which that impulse is aroused. The whine of a bomb, a lion at bay, a skidding motor bus, are three very different objects, but they all arouse the same emotion: fear.

Function of Emotion

Emotion often makes it difficult to think clearly, and thus might hinder the successful outcome of an action, but it strengthens striving and increases concentration of attention on one goal to the exclusion of all others. Under emotional stress, we can perform deeds of which we should be quite incapable in cold blood.

The importance of instinct can hardly be over-estimated; since our instincts provide raw material for the formation of character.

McDougall classified the instincts and his list contains fourteen

primary instincts. These are: flight, pugnacity, repulsion, parental instinct, appeal, sex, curiosity, subjection, assertion and self-display, gregariousness, food-seeking, acquisition, construction, laughter.

This is a practical and useful classification in analysing human behaviour; but there are others more comprehensive, based on our fundamental needs. We thus have self-preserving, race-preserving and herd tendencies, or ego instincts, sex instincts and herd instincts.

Another classification is into instincts of attraction, repulsion and aggression, while others have divided instincts into two classes, depending upon the presence or absence of emotion.

The instincts we have mentioned may all be regarded as the expressions of one elemental energy. The psycho-analysts call this energy the libido and regard it as sexual in nature; but it should be observed that for the psycho-analysts the word sex has a much wider meaning than it has in ordinary speech, all forms of sensuous gratification being regarded as sexual.

Libido, or Life Force

Other psychologists regard the libido as identical with the life energy or will-to-live: the energy which, according to an Eastern saying, "sleeps in the mineral, dreams in the plant, wakes in the animal, and becomes conscious in man." The notion of libido, or life force, or will to live, is very helpful, but if one aspect of it is over-emphasized an unduly simple explanation of human psychology results. Various attempts have thus been made to explain human life in terms of one great instinct only.

Biologists have stressed the struggle for existence and the survival of the fittest and have implied that self-preservation is the one instinct which explains human life.

Freud's Theory of Sex

Freud's teaching has acted as a corrective of this view, but he has made a similar mistake by making the sex impulse the key to all conduct. As the word sexual, as used by Freud, can be ascribed to any desire which is expressed by the phrase "I love," and as we love many objects for which we cannot correctly be said to have any sexual feeling whatever, Freud's use of the term sex loses a lot of its meaning.

Adler, originally a follower of Freud and who afterwards took an independent line, stresses the mastery tendency, the will to power, exerted to overcome inferiority, as the mainspring of conduct; Jung, another disciple of Freud who broke away, combines the views of Freud and Adler and teaches that the libido comprises the sex and the power instincts; Trotter, in his *Instincts of the Herd in Peace and War*, states that the herd instinct dominates human conduct.

All these attempts to explain life in the terms of one instinct break down in practice.

Sex behaviour can arise in two ways: in response to an inner need,

or in response to an outside stimulus. Sex, therefore, involves appetite as well as instinct; but it is unwise to over-estimate the part played by appetite. Although the appetite is certainly very powerful, absence of any stimulus, namely, an attractive member of the opposite sex (either real or in imagination) greatly reduces sex desire. Sometimes a sex desire is thought to be due to appetite, when in fact it is being stimulated by an imagined object.

Sublimating the Sex Impulse

The existence of sex appetite must however, be recognized. In civilized life it cannot always be naturally satisfied, and must frequently be sublimated, that is, lifted up. This is effected when an impulse is expressed on a higher level than that of mere personal gratification, by diverting it from its natural end and redirecting it to ends which are both satisfying to the individual and are of benefit to the community. The sex instinct is thus frequently sublimated in artistic and other creative work.

The biological end served by the sex instinct is reproduction. That is not to say that reproduction is a conscious aim in all sex behaviour; but any behaviour which, in the natural expression of the sex tendency, would normally lead up to the sexual act is described as sexual. The various activities of courtship are, therefore, so described.

In the ideal courtship there is probably, at the outset, no desire for, perhaps no imagining of, physical union; but the many activities in preparation for marriage—getting a home together, training to increase efficiency in trade or profession—are all largely expressions of the sex instinct which in its awakening gives vitality and zest to numberless activities of both partners.

The sex impulse is not a simple impulse of sex attraction. It is a composite impulse and includes self-display and a desire to be admired. In the male it includes self-assertion; submission is regarded as more in evidence in the female, but both impulses find expression in both sexes.

A most important element is the creative impulse. This is primarily, of course, for the creation of the child; but any creative work can be the sublimated expression of the sex impulse. In woman especially, the parental tendency is an important factor in this complex impulse. This is, of course, for the care of offspring; but it is often shown by mothering the husband.

The race would not survive without the sex instinct; but the impulse also adds to the joy of living; it motivates in large measure social relationships, art and literature. It is like a strong and lively horse, that can do excellent work only if properly controlled.

Self-assertive Impulse

Self-assertion (including self-display), also called the mastery tendency or will to power, is a

tendency to emphasize one's own importance among one's fellows. Children unashamedly show a desire to dominate, and though adults hesitate to admit it, it is a fundamental instinct in all.

Man's Use of Power

The perverted love of power for its own sake has brought untold suffering to mankind; but the race has benefited greatly from individuals of commanding personality who have used their power for good. We need not express our self-assertive tendency only in seeking to dominate others, we can master our jobs, overcome difficulties, achieve success in science and art, including the most difficult art of all—the art of living.

The will to power on which Adler founded his system of psychology is an exaggerated form of self-assertion. It is often exerted to overcome inferiority; many men have achieved far more than they otherwise would have done because they were suffering from some inferiority which required great assertion to overcome.

Demosthenes, in order to become the silver-tongued orator, had to overcome great physical disadvantages. He had a weak voice and he stammered; but by unwearied exertions he succeeded. He cured himself of stammering by learning to speak clearly with pebbles in his mouth; to strengthen his voice he repeated verses of the poets as he ran up hill. To become used to the noise and confusion of public meetings he practised speaking amid the thunder of the waves on the seashore. To acquire a good style and mastery of language, he lived for months in a cave underground constantly writing out the history of Thucydides.

Although in everyday life we do not crudely seek to dominate others, we often find that our behaviour is a disguised form of self-assertion. The desire for advancement in one's occupation is not solely due to a desire for more money; there is the desire to be over others, to give them orders. The amassing of money is largely prompted by desire for the power which money gives.

Instinct of Self-display

This aspect of the self-assertive impulse plays a bigger part in our lives than we care to admit. It is an inherent tendency to advertise one's qualities: physical, mental or moral.

In the animal world self-display seems to be essentially sexual. The male bird, for example, struts before the female showing off his beautiful plumage and form. Children "show off" from very early years and in adolescence the girl will show her physical attractions and the boy his prowess under the influence of the maturing sex instinct.

Many forms of egotism result from the determination to display the self at all costs. The egotist will parade his faults, will boast about his breaches of good taste or even his wrong doing. Other forms of

egotism include making one's health or lack of it, or one's own affairs generally, a frequent subject of conversation; laying down the law; and officiousness.

Importance of Submission

The instinct of submission, or self-abasement, is as true an instinct as any other, and is not mere absence of assertiveness. If we had no tendency to submit, we should continue to strive against impossible obstacles until we dropped. We are not fond of beating our heads against brick walls.

This instinct is one of the most important in social life. It is the basis of that imitativeness and suggestibility without which social life would be impossible. Unfortunately, in recent years submissiveness has been exploited and we have seen a tragic subordination of men and women to the state. It is only a partial view which regards fear as the sole motive for such subordination. Submissiveness is an essential constituent of such desirable qualities as devotion, gratitude and reverence.

The herd, or gregarious instinct, is of great social importance. It prompts us to seek and retain the company of others. Indeed, it has been said that to be alone is one of the greatest evils for man, and solitary confinement is considered one of the severest forms of punishment.

Gregariousness is not the same as sociability. The herd instinct is satisfied by the company of our fellows; we do not necessarily desire social intercourse with them. A gregarious but unsociable man likes to be with the crowd but not of it; he will rebuff any attempt at conversation.

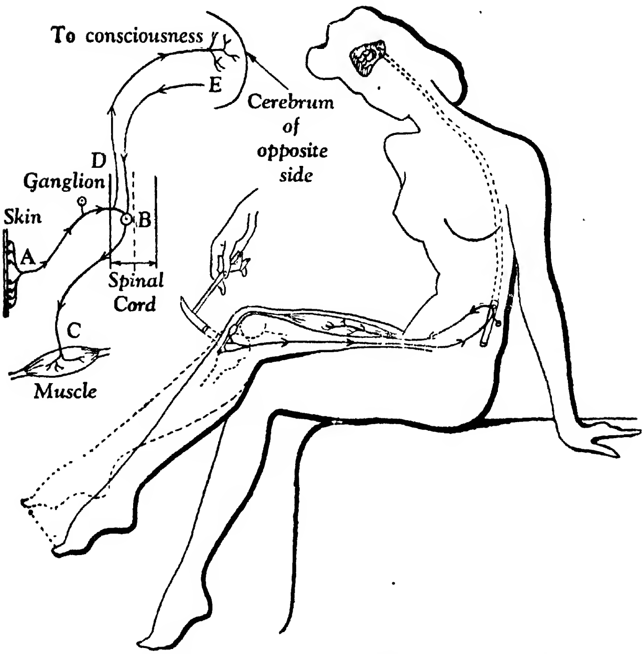
The huge crowds at games and other spectacles are attracted not only by the show but by the knowledge that thousands of others will be present. How many would go if they thought that they would be the sole spectators? The herding together into huge towns is not entirely due to economic necessity; it is also due to gregariousness.

We should maintain balance and refuse to be over-dominated by the herd. The rights of the personality must be strictly maintained.

Modification of Instincts

An old and unsound view was that the instincts provide the power to operate intelligence or reason as a machine which has no function except to serve and obey them; but it is now recognized that although our instincts greatly influence our thinking, and although we often use our intelligence to find reasons for doing what we have already decided to do on the urge of some instinct, our intelligence can act quite independently of instinctive prompting and can modify and direct the instincts by changing the direction of their expression. The instinct does not become a new instinct, but becomes habitually evoked by a different stimulus.

For example, curiosity can be modified by diverting it from morbid and unhealthy objects, and



NATURE OF REFLEX AND VOLUNTARY ACTIONS COMPARED

When the knee is tapped the impulse travels to the centre in the spinal cord and from there the motor nerve sends out the impulse causing the knee jerk. Diagram (left) shows course of message from the skin receptors to the muscle (ABC), also the course of a voluntary action through the brain (ADEBC).

expressing it in scientific research.

The process of modifying instinctive and other unlearned responses by redirecting them to new ends is very important in the training of the child. Indeed the Behaviourist school of psychology regards the process (calling it conditioning) as the key to mental development. In conditioning, a natural stimulus evoking a given response is replaced by a new stimulus, the conditioned stimulus.

The pioneer experiments on conditioning were performed by Pavlov, on the salivary reflex of dogs (page 106). These experiments established a new reflex, the conditioned reflex, whereby the ringing of a bell caused saliva to flow.

The Behaviourist, therefore, tries to rewrite psychology in terms of

stimulus and response, habit formation and integration. All the psychologist is entitled to do, says the Behaviourist, is to observe what response a person makes to a stimulus. This response is always a physical movement. What the individual says goes on behind this movement; what he feels, or thinks, or desires, does not in any way interest the Behaviourist.

To explain thinking as a physical stimulus would appear to be difficult; but the Behaviourist makes no mystery of thinking. Thinking is behaviour, is motor organization just like any other form of muscular activity. The muscular activity is that used in talking. Thinking is simply talking—there are unseen movements of the speech organs.

Behaviourism, although marred by absurdities in its extreme form, possesses much of value. It studies behaviour with a view to its prediction and control and its direction to morally and socially useful ends. It has great faith in the ability of science to direct human affairs.

The Child Mind

The claims concerning child training made by the Behaviourists may be fanciful; but it is beyond question that the early years are vital. Rousseau said, "Childhood has ways of seeing, thinking and feeling peculiar to itself; nothing is more absurd than to wish to substitute ours in their place."

The treatment of children should, therefore, be based on the psychology of their immature minds and not on that of mature minds. It is true that "the child is father of the man" but this does not mean that children are little adults, but that tendencies acquired in childhood determine adult character.

Infancy, from birth until the third year, is the period of swiftest learning, in which the infant has the task of building up an intelligible world out of his confused environment. The period from the third to the seventh year is a dramatic age: the age of fairy tales, in which is seen the world as Stevenson saw it in *A Child's Garden of Verses.*

> "The world is so full of a
> number of things
> I'm sure we should all be as
> happy as kings."

The Growing Child

As the child grows older, fairyland flees and he enters a trying period, trying to parents and teachers. It evokes such remarks as that of a distracted mother who said, "Go and see what Tommy is doing and tell him he mustn't." Both the furniture and the good humour of those looking after children of this age need strong and buoyant springs. This age gives way to the difficult one of early adolescence—the threshold of the period of storm and stress.

Inborn intelligence normally ceases to develop when the child reaches adulthood. Intellectual development, on the other hand, may continue throughout life, as this involves the organization of our

knowledge and abilities as well as our intelligence.

It is in emotional development that the growth from childhood to adulthood is best shown; and until emotional maturity has been reached a person is still psychologically a child (on this score, many people of sixty are still childish). A person is no longer childish when:

1. He is capable of gradations of emotional response; he does not give an all-or-none reaction, he suppresses the reaction at least in part. A little child, on being hurt, generally gives himself over entirely with loud lamentations to his distress, but the outburst may suddenly cease if his attention is attracted elsewhere.

2. He can delay his response and check the activity which an emotion prompts. If frightened, he does not necessarily run away at once.

3. He handles self-pity in a different manner from that of the child. He tries not to be sorrier for himself than he is for others.

Primitive Tests of Maturity

It is of interest to note that in the ancient pubic ceremonies of savage tribes, emotional maturity was regarded as evidenced by fortitude. Many of the most conspicuous tests of fitness for manhood and womanhood at these ceremonies were tests of capacity to suffer. The boy would be held close to the fire or would have teeth knocked out with a chisel and mallet and be expected to bear the pain without a murmur.

In our early years, we form our general attitude towards life and, what is even more important, to ourselves. The child is very suggestible, that is, accepts ideas without criticism, and is, therefore, greatly influenced by the beliefs and manners of behaviour of those around him. Sometimes, however, if adults endeavour to offer too strong a suggestion to a child, just the opposite effect is achieved.

Child's Attitude to Life

The general attitude to life formed during childhood tends to remain. For example, life may come to be regarded as hostile, or easy. Habits of confidence, pessimism, stoicism or snobbery are induced. The attitude adopted may be natural and inevitable for the child, but quite unfitting for the adult, and unhappiness and distortion of character may result.

The attitude a child forms to himself is of cardinal importance. Self-consciousness is first developed in childhood and the view of the self first adopted tends to persist. We thus may feel that we are superior, or inferior, to others; are not muscular enough for this; too refined for that; too prone to overestimate difficulties, and so on. We learn our abilities and limitations. A phantasy of the self may be formed. A child, and a man too, unwilling to admit inferiority, will seek gratification in an extravagant phantasy of which he is the hero.

CHAPTER TEN

MENTAL ABILITY AND INTELLIGENCE

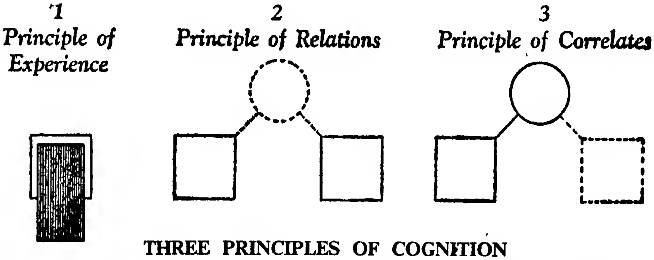
Three principles of cognition. Imagination and ideas. Meaning of concept. Four kinds of judgment. Reasoning, or mental exploration. Four aspects of memory. How memory can be improved. Importance of an aim in life. Employment of will power. Nature of intelligence. Value of intelligence tests.

COGNITION manifests three laws or processes, called by Professor Spearman, who formulated them, the Principles of Cognition. The degree of general mental ability we possess depends upon the degree of quickness and accuracy with which these three processes operate in our thinking.

The first is a truism: "A person tends to know his own sensations, feelings and strivings." Whenever we have an experience we immediately know, or tend to know, its characteristics. A sensation has quality, intensity, place and time. Thus, a flame arouses a sensation of sight; this sensation has quality, say a reddish colour; it has intensity, it is of vivid brightness; we obviously refer it to a particular place and time.

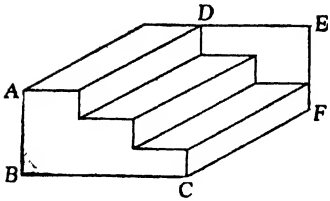
It has been computed that the grand total of the qualities of sensations is about twelve thousand; this total is but a part of the almost limitless gamut of experiences of which we can become aware.

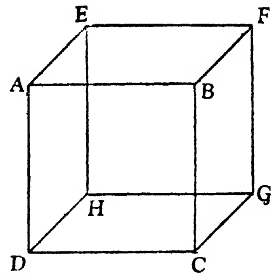
The second principle is the principle of relations: "When two or more items (percepts or ideas) are given, a person may perceive



THREE PRINCIPLES OF COGNITION

These principles, described in the text, are represented in this diagram. 1 represents the experience (dark rectangle) and the knowing of that experience (square outline); 2 the perception of the relation between two ideas (shown as squares); and 3 the bringing out of the mind an item (dotted square) bearing a given relation to another item (square on left). (From Professor Spearman's "Creative Mind," published by J. Nisbet & Co. Ltd.)





REVERSIBLE PERSPECTIVE

Perception is an active process. Thus our perception of these figures varies and we may see the staircase on the left from above or below, i.e. ABC or DEF may appear nearer to us. In the cube ABCD or EFGH may be nearer.

them to be in various ways related; thus, one may be near, after, the cause of, or a part of, the other."

This principle, like the first, seems obvious. Simple instances are hardly worth the stating: the stroke of the bat obviously causes the flight of the ball; but the identification, amid a mass of confusing detail, of the cause of a particular effect often demands a high degree of intelligence. The relationship of oppositeness between heat and cold is easily seen; but the relationship between aspect and space, or between phase and time, is not so readily observed.

The third principle is that of the eduction of correlates, or the bringing out of the mind of an item which bears a given relation to another item. Simple examples of this third principle, too, are obvious. We see at once, for example, that as black is to white, so is bad to good. Being given the ideas, the relationship of oppositeness between black and white is given us by the second principle. By the third principle, we apply this relation to "bad" and educe the correlate "good."

Perception, although regarded as a simple form of thinking (see page 202), may be very complex. This is shown by the above figures. The geometrical patterns do not change, but our perception of them does; their meanings fluctuate. The self is not a mere passive recipient of impressions, but perception is an active process.

It sometimes even fills gaps in a figure, and we perceive, for example, an incomplete circle as complete; we see a word as a whole, not each letter separately, and thus overlook misprints. A collection of similar objects, say of dots on paper, is seen in groups and patterns.

A higher process is thinking of an absent object. When I perceive my house before me it may be said to produce in me a mental impression.

Later, many miles away, I reproduce that impression; in other words, I imagine the house. Both in my perceiving, and in my imagining, the house can be regarded as the cause of the impression, or its mental representative.

Ideas and Images

This representative we call an idea of the house. The word idea has several meanings (a representation, a conception, a concept, a notion, a universal); but at present we will regard the idea as the effect in us of the thing it represents when the thing is absent. This effect is not due directly to a stimulation of our sense organs. I hear Beethoven's Fifth Symphony over the radio, my experience arises out of a direct stimulation of my sense organs; but long after the music has finished, I can imagine that I still hear it. In other words, I have an auditory image.

Ideas are frequently confused with images. All images are ideas, but all ideas are not images. An image possesses the qualities of a perception, although the object imaged is not present. There are as many types of images as there are types of sensation. For example: a visual image is "seen"; an auditory image is "heard"; an olfactory image is "smelt"; a kinaesthetic image, that is an image of movements of the limbs and body, is "felt."

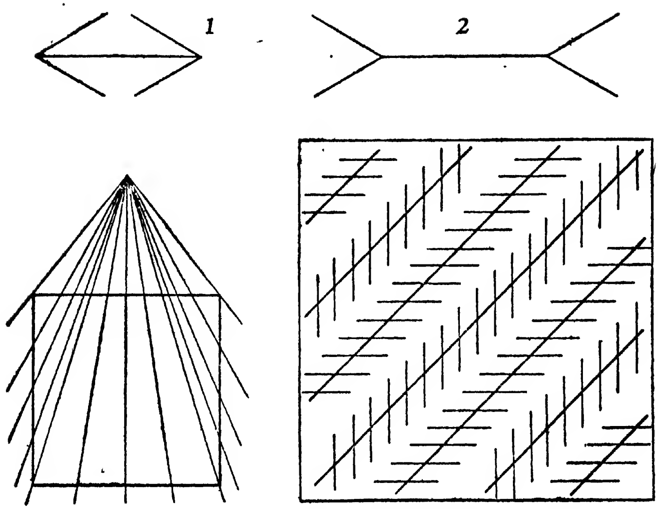
Individuals differ greatly in their type of imagery. One man's images may be mostly visual; another's, auditory. Some people state that imagery is unknown to them, while the images of others, children in particular, are so vivid that they have difficulty in distinguishing them from sensations. If an image is taken for a real object it is an hallucination.

The verbal image is not a special type of image, but is merely the image of a word. Such images may be of three kinds: visual (when we see with the mind's eye a written or printed word); auditory (when an imagined voice is heard with the mind's ear); or motor (when the image corresponds to the sensations in the speech organs during speech). This type will sometimes help in the recall of forgotten words in a line of poetry if the context is known. The remembered words are recited and the speech organs, having retained a motor image, automatically produce the forgotten words.

Meaning of Concept

In the previous chapter (page 199) the four laws of the association of ideas were stated. But association seldom acts unguided, except in reverie, when we allow our thoughts to wander. Association is guided by our interest at the moment. If I am thinking about cricket, the ideas associated with the thought, bat, will be quite different from those which will accrue if I am thinking of belfries.

This process of association of ideas is thinking on a comparatively low level. Abstract or conceptual thinking is on a higher



HOW PERCEPTION DECEIVES US

The above illusions show how we may be deceived in our perceptions. Although they do not appear so, lines 1 and 2 are the same length, the lower left figure is a square, and the long lines in the right-hand square are parallel.

level. A concept is related to a class of objects or experiences. The concept insect refers to all insects; the concept energy refers to all forms of energy.

Thus, in perceiving an object, say a favourite chair, it is recognized no matter from what angle, familiar or unfamiliar, it is observed. Further, not only is this particular chair recognized, but all chairs, however much they differ in design. There are, therefore, particular ideas of particular chairs, and the general idea, or concept, chair.

In using abstract concepts, such as goodness, truth and beauty, we regard these qualities as realities existing independently of any particular manifestations in objects or in conduct.

In essence, a judgment is an answer to a question; it is of the form, "this is that." There are different kinds of judgment, but in all the mind brings together two concepts or ideas and ascertains whether they agree or differ.

I observe two small creatures moving across the path and I make the judgment that they both look like insects. Closer examination, however, shows that one, a beetle, has six legs and the other, a spider, has eight. This difference leads to a further judgment that both

cannot be insects, as one of the essential qualities of the concept insect is six-leggedness. Further examination shows that the beetle has other qualities peculiar to insects. The final judgment is therefore made: "It is an insect."

Judgment and Reasoning

There are four kinds of judgment:—

Of expediency: "Smith ought not to have gone out without his raincoat."

Aesthetic judgments: "Mrs. Smith ought not to dress in such bright clashing colours."

Of fact: "India is warmer than England."

True ethical or moral judgments: "Smith is a swindler."

What we call sound judgment is not merely a function of intelligence, but of character. It implies careful consideration before action; a sound criticism not only of the end in view, but of the means to be used to achieve it. The vital importance of relative values is not overlooked. We prefer to ask advice of a man of sound judgment rather than of a man of more brilliant intellect but of lesser judgment.

Reasoning, well described as mental exploration, enables us, by inference from certain given facts, to discover further facts. In the old problem a man standing before a portrait states these facts for us: "Brothers and sisters have I none, yet that man's father is my father's son." From these we infer the further fact that he was looking at his son's portrait.

A false inference, or fallacy, arises from failure to notice the exact relationship between the facts from which we are making an inference. If John and Tom both resemble Peter, it is fallacious to infer that John resembles Tom, because John may resemble Peter in one respect and Tom may resemble him in another, and there may be no resemblance whatever between John and Tom.

An unsound conclusion may also be reached, even by perfectly sound reasoning, because the facts from which we infer are unreliable.

Reasoning is of two types: induction, when a general principle is sought which will explain certain facts; and deduction, when a known general principle is applied to particular cases.

The method of induction is followed by the scientist when he collects facts and endeavours to discover the general principle or law which explains those facts.

Galileo's Experiment

For example, before the days of Galileo, it was believed that if two unequal weights were dropped from a height, the heavier would reach the ground first. Galileo, however, experimenting from the Leaning Tower of Pisa, disproved this theory by showing that they reached the ground with equal speeds; and by amassing facts in a series of such experiments, arrived by induction at the general law

SIGNPOST TEST OF REASONING

Walking from Oxford a man comes to a fork in the road where the signpost has fallen down. Which road, A or B, should he take for Salisbury? This is a simple test problem, and by reasoning that the arm marked "Oxford" should point along the road he has come by, he finds that A is the right road.

governing the acceleration of falling bodies due to gravity.

Induction, depending upon the gathering of facts, and on "scientific guessing," is not an absolutely certain process, as further facts may be found which contradict the conclusions already reached. On the other hand, deduction, provided the general law which is being applied is sound, is a process by which we can reason with certainty. But the general law, the premises, must be sound, otherwise by a perfectly sound chain of reasoning from false premises the veriest nonsense can be deduced.

An argument is thus not established merely because it is logical. Perfect logic may lead to perfect nonsense because the premises are wrong. A patient at a mental hospital may argue quite logically from the false premises that he is made of glass. On matters unrelated to this delusion he is quite normal, and his reasoning based thereon is strictly logical.

A visitor to the hospital converses with him and wonders why such an intelligent and normal individual should be certified. He knows the reason when he tries to shake hands on leaving and the patient exclaims: "Don't touch me. I'm made of glass!"

We are often prevented from reasoning clearly by the state of

our feelings. Under the influence, for example, of increasing anger we become less and less reasonable. Feeling clouds judgment even when we are unaware of any emotional stress, as when our thinking is swayed by prejudice.

Prejudices are bad emotional habits of deciding a question not on its merits, but according to our personal feelings toward the person or subject concerned.

Feeling is also an aid to clear reasoning, and is essential in many thinking processes of the highest type. The explanation of this apparent contradiction is just this: if feeling comes before the reasoning process it is in the wrong place and hinders clear thinking; if feeling follows a careful and exhaustive intellectual process, it helps.

Solving a Problem

Original thinkers, scientists, mathematicians, even poets, all testify to the fact that their train of thought in trying to solve a problem covers first a period of reasoning when every possible attempt is made to reach a conclusion. If the solution is elusive, there is next a period of relaxation, or of attention to an entirely different question. During this period of incubation as it were, we assume that the unconscious mind is working on the problem.

This period ends with the required solution flashing into the consciousness, and often the first intimation the thinker has that the correct solution is coming is when he feels that it is the solution for which he is searching.

A great mathematician knew that he had solved his problem when he felt that a proffered solution was beautiful! This influence of feeling on such logical reasoning as in mathematics is especially interesting. After the correct solution to the problem has been felt it is verified by the ordinary processes of reasoning.

Influence of Feeling

Again and again great thinkers testify that after a period of intellectual preparation, followed by a fallow period, they feel that a solution is right and find reasons in support afterwards.

A judge, well known for the soundness of his decisions, was asked his methods, and confessed that he heard and carefully weighed all the evidence, brought all his intellectual power and his knowledge to bear on the case, then waited until he felt one way or the other and gave his decision and reasons accordingly.

It must be stressed that this legitimate use of feeling as an aid to thought always follows hard thinking and a fallow period, and is followed by an intellectual process of verification of the solution obtained by feeling.

Intuition is sometimes an example of the process we have been discussing. A person, experienced, say, in observing human beings, or as a student of a particular subject, sees or feels by intuition, and his

decision seems to be instantaneous and without any preparation. In fact, the previous experience and study have provided the necessary period of preparation.

Process of Memorizing

The four aspects of memory, as stated in the preceding chapter, are: committing to memory; retention; recall; and recognition. The memory process has fascinated thinkers throughout the ages. How the details recalled by memory are dated is inexplicable, but we know, not merely assume, that a certain event took place round about a certain time. Many people, who have no special interest in psychology, are keenly interested in memory. They attribute efficiency, or lack of it, to the possession of a good or bad memory.

We can distinguish two kinds of memory, rote memory and logical memory. In rote memory, material is committed to memory and reproduced without any regard to its meaning. In logical memory, the material is always meaningful. So powerful a factor in memorizing is the meaning of the material to be memorized that in laboratory experiments on rote memory nonsense syllables are used, e.g. wok, bip, zut, etc., and the subjects are instructed not to import meaning into the syllables.

Experiments show that memorizing is not merely the passive receipt of impressions, but is active. Even in learning nonsense syllables meanings are introduced; the syllables are heard in rhythm, or seen grouped in pairs, and similarities and contrasts are noted. It is clear, therefore, that grouping of the material, and seeing relations and meanings, are the keys to effective memorizing. The factors of advantage in memorizing can be summarized as follows:—

The Emotional factor: interest in the subject, confidence in one's ability to memorize, and the encouragement which comes from progress are of great help.

The Recency factor: we forget material so quickly that to "strike while the iron is hot" is most important. Having just learned material, to re-learn it then and there is of advantage.

Meaning: the meaning of the material, its outline and relationships between its parts, should be observed. Images aroused often help the process. This factor of meaning outweighs in importance the first and second factors, especially with experienced learners.

Methods of Learning

The question arises whether it is more efficient to learn the material in wholes or in parts. Experiment shows, perhaps to the reader's surprise, that the whole-learning method, when really practised, is more efficient than learning a part before proceeding to the next part. Many reciters, who have learned the verses of a poem separately, break down at the end of a verse because they have not learned any relationship between the end of one

verse and the beginning of the next.

If the time available for learning is spaced over several sittings, the memorizing is more successful than if the whole time is spent in one period.

With regard to the two devices just mentioned: whole or part learning and spaced or unspaced learning, we find that the emotional factor of advantage in memorizing is on the side of part learning, especially with beginners, as the learner has the satisfaction of quickly mastering something—if only a small part. The factor also supports unspaced learning. The learner being interested in the material would rather keep on learning than wait until next time. The recency factor favours unspaced learning and part learning.

In spite of this support by the first and second factors of the part learning and the unspaced learning methods, the third factor is on the side of whole learning and outweighs the other factors. The effect, therefore, of observing the meaning and relations in the material to be learned is so great that spaced learning and whole learning are the efficient methods.

Use of Mnemonics

A mnemonic helps to memorize material in which there is no logical plan; but such an aid should not be used unless it is impossible to find such a plan. There is, for example, no logical reason for the difference in the numbers of days in the months and few people have not used the useful mnemonic beginning: "Thirty days hath September. . . ."

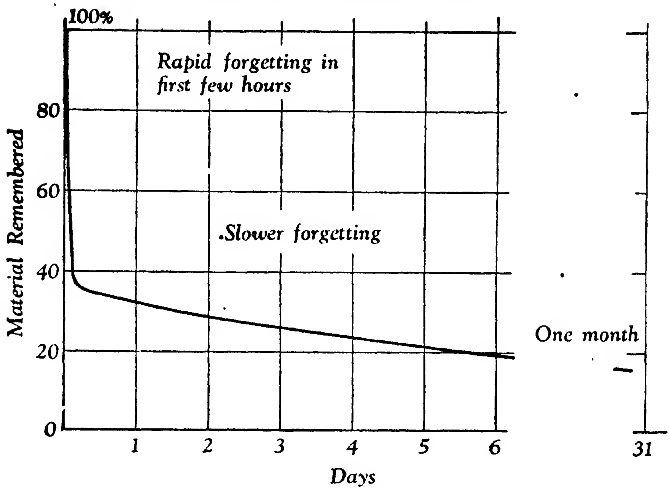
It is doubtful whether sheer retentiveness can be improved (the fact of retention, of course, depends on the efficiency of the methods of committing to memory). Retentiveness seems to be an innate quality. It may have a physical basis. It varies with the state of the health; and is adversely affected by overwork, over-feeding or drinking, in fact, any form of over-indulgence.

Some people memorize so easily that their minds may be said to be like wax impressed by a seal, every impression is clearly retained; the minds of others are like jelly and vibrate to every touch, but usually retain no mark.

Facilitating Recall

There are few practical aids to recall. We frequently find difficulty in recalling an item we know we have memorized; something seems to be blocking the recall, perhaps fear, anxiety, doubt or stage-fright.

Recall may be facilitated if we give the stimulus which is linked with the item we are trying to recall, a good chance. We should, for example, look squarely at a person whose name we are trying to remember and avoid doubting that we can recall it. To think of the circumstances of a previous recall of an item we are now trying to recall, or to picture our first experience of the item, is very helpful. If these attempts fail the



CURVE OF FORGETTING

This graph shows how much material is retained by the average person during the course of a month. In the first few hours over 60 per cent of the material is forgotten. The curve is then much more gradual, about 20 per cent being remembered after six days, and about 15 per cent by the end of the month.

matter should be dropped. It is often found that after a time the blockage is released and the item comes into consciousness.

When recall has succeeded, it remains to be decided whether the fact recalled is the same as that committed to memory. Sometimes a fact may be recalled and not recognized, an interesting example being unconscious plagiarism; conversely, we frequently recognize items we cannot recall; thus we may be unable to recall the name of a tune, but immediately it is mentioned we know it is correct.

Recognition of an object includes perception of that object and a "feeling of familiarity": this is recognition at its simplest. But it may be very complex, as when not only do we recognize an item, but all its manifold attendant circumstances which formed its setting when last we perceived it.

In conclusion, the effect of interest on the efficiency of memorizing must be stressed. It has been well said that all have good memories for something or other. A boy, who found the utmost difficulty in remembering the kings of England, memorized, without trying, the names of scores of professional footballers, their clubs, and positions on the field.

To arouse real interest is one of the best known aids to memory.

The greatest aid to mental efficiency is a clear aim. As the magnetic pole gives direction to the compass needle, an aim gives direction to mental endeavour; to say, "I will do it" is more likely to lead to success than, "I will try."

Choosing an Aim in Life

The aim chosen should have a strong appeal for us and must be neither too easy nor too difficult. If the aim is a very distant one, there should be intermediate aims. We thus observe our progress stage by stage toward the goal; this observation increases our efficiency.

Clearly, to keep aims before the mind requires the exercise of will power; and this will not have its maximum effect unless the aims are in harmony with one's main aim and purpose in life, with one's ideal. A worthy ideal is necessary if the whole self is to be stimulated to action, or, in other words, if the will is to operate at full power. This state of harmony is not only a condition of mental efficiency, but of mental health.

Will is necessary for concentration of attention. When studying a new subject there are three phases. The first is a time of examination and exploration when our attention is held because the subject is new; we are prompted by curiosity.

The second phase is the difficult one. We are no longer curious and an effort is required to attend to the subject. Various other motives are brought in to assist this process. The attention of children to a distasteful subject has been frequently induced by fear, or by self-assertion aroused in rivalry with other children, or by rewards.

The third period begins when increasing knowledge of the subject leads to an awakening of interest in the subject itself. Most, if not all, subjects are interesting if studied deeply enough.

Another important aid to mental efficiency is the proper use of time. Dante said: "All our annoyances, if we care to look for their source, arise from our not rightly understanding the employment of time."

We are often distraught, hot and bothered, and hurried, because our time has not been apportioned properly. This apportionment will depend upon our aim in life, but all should endeavour to put first things first. Without reducing necessary relaxation, time can be reclaimed from inferior pursuits; people who would waste our time can be gently and firmly dealt with; and odd minutes can be gathered. Some of us fret and fuss if kept waiting, while others use the unexpected interval wisely.

Nature of Intelligence

In intelligent behaviour, a new situation is met more or less quickly by improvising a novel and fitting response. As a result of training and repetition, quite complicated tasks can be performed by persons of average intelligence; but intelligence of a high order is required to

meet a new situation, one for which there is no precedent.

There has been considerable controversy as to the nature of intelligence, but, mainly owing to the researches of the Spearman School, it has now become evident that intelligent behaviour depends upon two factors: a general factor (general mental ability or "g") which is inherited, and a specific factor which is largely acquired.

This general ability is what Dr. Johnson had in mind when he said in reply to a suggestion that one man might have clear judgment, another great learning, another vivid imagination: "No, sir, it is only that one man has more mind than another. He may direct it differently; he may by accident desire to excel in this study or in that. Sir, the man who has vigour may walk to the east, just as well as to the west." Dr. Johnson even suggested that Sir Isaac Newton, if he had so applied himself, would have become a great poet.

Diagnosis of Mental Ability

Spearman's researches show that our general ability depends on quickness, clearness and accuracy in manifesting the three principles of cognition mentioned at the beginning of this chapter. Some abilities, say in mathematics or philosophy, depend almost entirely on "g," the inherited general factor, and any ability specific to those subjects does not figure very largely; but in mechanical skills, in singing, drawing and the like, the specific factor is as important, or more important, than "g."

General mental ability increases rapidly in early years, then more slowly towards the age of fourteen. The exact age at which "g" ceases to grow is still a matter of inquiry; but it appears to be about sixteen in normal children.

Testing for Intelligence

Intelligence tests are based upon the three laws of cognition already described, and include questions testing the ability to see similarity and difference, to classify, to see analogies and inferences, and so on. For those who, for one reason or another, have not the usual facility in using language, performance tests, such as fitting together various shapes, completing pictures, discovering the principle of simple mechanisms, are used.

The process of education provides material on which a child's native endowment of intelligence can work and develop, but education will not increase a person's intelligence beyond his limit; by analogy, physical exercise will not increase the size of a man's muscles beyond a certain limit depending upon constitutional factors.

A child's backwardness may be innate, being due to lack of intelligence, or acquired, being due to loss of schooling, poor health, defects of sight or hearing, stuttering, left-handedness. Intelligence tests have proved invaluable in determining whether backwardness is, or is not, due to innate defect.

CHAPTER ELEVEN

PSYCHOLOGY IN DAILY LIFE

Psychology and education. Improved methods of learning and teaching. Improvements in working conditions and increase of output. Guidance in selection of vocation. Study of the causes of crime. Researches into the accuracy of evidence. Psychological treatment of functional nervous disorders.

MODERN psychology, far from being merely theoretical, is of practical use in many aspects of everyday life. As we have seen, intelligence tests devised in the process of child education are a valuable guide to mental ability and help in choosing a job.

Intensive research in the field of educational psychology has made available knowledge of the child mind which has provided a basis for improved teaching methods. Such methods are very different from those of the schoolmaster described by Charles Dickens in *Hard Times*, who regarded his pupils as "little vessels, then and there arranged in order, ready to have imperial gallons of facts poured into them until they were full to the brim."

Today the child is regarded, not as a mere receptacle of facts, but as a developing personality.

Child Guidance Clinics

Psychology not only helps a teacher in his teaching, but at child guidance clinics provides advice and treatment if children are difficult and maladjusted. Children who are backward, nervous, or delinquent, benefit from these clinics, where they are received not with blame but with understanding.

A third valuable aid provided by modern psychology is the devising of special methods of teaching particular subjects.

Grading by Ability

Psychological research into the nature of intelligence has yielded tests whereby children can be graded according to their ability to learn. If children are classified merely according to age, the most capable pupils will waste time waiting for their slow class-mates to catch up; on the other hand, a number of children below average intelligence will not grasp what is being taught, but will become discouraged and the seeds of an inferiority complex may be sown.

Some children are shown to have such a low mental ratio that they are incapable of benefiting by tuition in ordinary schools; such mentally defective children are sent to special schools where they are trained for tasks within their powers.

In recent years examinations for scholarships have included not only questions in the ordinary school

subjects, which may tend to be mere tests of knowledge, but tests of mental ability. This new method is more reliable than the old in picking out pupils best able to benefit from further education.

Child's Natural Impulses

The application of psychology to education has led to a marked change in outlook on a child's naughtiness or mischievousness. Instead of being regarded necessarily as an expression of "original sin," they are regarded as due to perfectly natural and healthy impulses seeking an outlet and which can be expressed in self-control if the child is wisely trained.

All the impulses of the child need training, but special difficulties sometimes arise with the more powerful instincts. For example, the fear impulse very rapidly becomes conditioned; that is, habitually aroused by objects other than the natural stimuli. A child thus easily acquires fears of objects not in themselves dangerous.

He must, of course, be trained to treat with a wise caution objects really dangerous; but unnecessary fears—of bogies, of tame animals, of the dark, of strangers, are very harmful and may lead to an habitually apprehensive attitude to life in general. Fear, too, is very contagious, and a wise parent or teacher tries to induce by example an attitude of self-control in the presence of danger.

Another impulse requiring careful handling is that of curiosity. It needs direction along healthy paths and should not be thwarted. A child's questions, even though they are embarrassing to adults, should not be met by evasions and untruths, but should be answered by the truth adapted to the understanding of the child.

Any other policy tends to encourage morbid curiosity and sometimes distress of mind; and when the truth ultimately becomes known the child loses confidence in the adult who was not honest with him. The healthier attitude adopted today toward the child's curiosity on matters of sex is due to the teaching of psychology on repression and its dangers.

Self-assertive Instinct

A child's instinct of self-assertion, showing itself in the desire for mastery and self-display, is sometimes difficult to control. Lack of control of this impulse, and of the anger impulse, is encouraged if the child finds that he can get his way by outbursts of bad temper.

Although arrogant manifestations of self-assertion and self-display are to be deprecated, the tendencies must not be unduly discouraged as there will then be a danger that the child will come to regard himself as inferior.

An unexpected manifestation of the assertive impulse is in some forms of juvenile delinquency. Lying, and even stealing, may be an expression of the desire to be impressive, to show off. Children sometimes steal money and spend

it all on their schoolfellows in an attempt to achieve easy popularity and notoriety.

Wise direction of the gregarious impulse, which does not become fully manifest until the "gang age" in early adolescence, is of vital importance in the education and character development of the child. The many organizations catering today for boys and girls are practical applications of the psychology of the gang age. At this age leaders emerge and if a teacher wishes to influence the group his task is almost accomplished when he has made sure of the leader.

Interest and Attention

Psychologists have assisted teachers in investigating the nature of attention. All of us pay attention to things which interest us; but the problem of the teacher is to get attention to the uninteresting.

Attention depends upon, first, the power of a stimulus to arouse native curiosity; second, habit; and third, desire and interest. Curiosity or involuntary attention is aroused when the stimulus possesses such qualities as change, repetition, strength, arresting quality, definite form.

The attention-arousing power of change is shown by a person's remaining unaware of the ticking of a clock until it stops. Any change, if not too gradual, arouses attention—change of position, of tone, of colour.

Repetition, too, arouses attention. Thus the more a melody, a slogan, a pattern in a design, are repeated the more they are noticed. Billposters will sometimes post on a given area of hoarding several small identical bills. These have more power of arousing attention than one large bill covering the whole area.

In attracting notice a strong stimulus has the advantage over a weaker one. A shout over a whisper, a large headline over small type.

Arresting quality is not the same as strength. But certain stimuli seem to strike us quite apart from their strength. Thus a very high note claims attention rather than a low note.

Definite form attracts attention rather than an ill-defined object. A mountain's clear-cut lines are seen to advantage with a background of sky or cloud.

Habits of Attention

Habits of attention are formed because certain stimuli are important to us. An engineer forms a habit of attending to the noise of a machine and notices any irregularity at once; a detective in investigating a crime attends to minute details. If stimuli are unimportant they tend to become ignored, no matter how intense, or how often repeated they may be. We thus soon become unaware of the roar of heavy traffic passing our window.

The interest or desire of the moment arouses attention. A boy on a railway journey who happens to be interested in the various types

of locomotives, notices their distinguishing features to the exclusion of other objects which would normally attract his attention.

Instinctive desire often determines attention. Thus the attention of children to dry subjects is sometimes obtained by threats of punishment, or by promise of reward, or by stimulating rivalry. Adult attention to advertisements is often captured by illustrating them by artistic pictures.

The child's natural tendency to play can be a useful aid to education. It is unnecessary to discuss the various theories of the essential nature of play; but play seems to be activity for its own sake, for the pleasure it gives. Games consist of play complicated by various other impulses, notably the assertive impulse. Both play and games enable the child to learn much which would otherwise be a dull grind. Play smooths the passage of the child from the freedom of the home to the sterner atmosphere of the schoolroom.

Improved Learning Methods

As a result of experiments in the psychological laboratory, improved methods of learning have been devised. The learning of all subjects is, of course, facilitated by the aids to memorizing described on page 223; but investigation of the learning process in particular subjects, notably "the three r's" and spelling, has had fruitful results.

By means of photographs of the eye movements of a reader as he looks along a line of print it has been found that his mental processes when reading aloud differ notably from such processes when reading silently. Silent reading is quicker than oral reading, as larger units are attended to. Instead of a word or two at a time several words are perceived at once.

Reading Silently

The absence of lip movements and inner speech from silent reading is another factor of advantage. In reading aloud the flow attention is interrupted by the separate articulation of each sound. Formerly in schools, instruction in reading was by reading aloud; but now the tendency is to encourage even young children to read silently.

The "look and say" method in modern reading lessons, whereby children learn the look of the word as a whole rather than building it up letter by letter, is an advantage and is a result of psychological experiment.

In arithmetic, experiments have been conducted to determine the best order to teach children processes of differing difficulty according to their ability to learn.

Analysis of the movements employed in handwriting has enabled series of exercises to be devised, designed to make such movements rhythmic and easy instead of awkward and angular.

Teachers are helped by the method of classification of errors. The mistakes made by pupils are recorded and classified and attempts

made to explain them. As a result, suggestions of improvement in teaching methods can be made.

To sum up, it may be claimed that the application of psychology to the process of education has resulted in increased efficiency in teaching methods and has made school a much happier place for the pupils.

Psychology in Industry

The contribution of psychology to the welfare of the individual does not end when the child leaves school. In later spheres of life—in the factory and workshop, for example—psychological research has been instrumental in improving conditions, with resultant benefit to the health and happiness of the individual during working hours.

During the nineteenth century, with its great improvements in machinery and increasing knowledge of the workings of the human body, the fallacious belief that man himself is a mere machine was widely held by all except a few enlightened employers.

A worker's output was thought to depend solely on the hours he worked. If a man produced ten articles in one hour, of course he would produce fifty in five hours, eighty in eight hours, and one hundred and twenty in twelve hours, and only the unfortunate need for sleep prevented a production of two hundred and forty articles per day!

At the turn of the century, however, it was realized that the worker is a very complex organism, requiring careful study if an increase in industrial efficiency is to be achieved; and the assistance of the psychologist was sought.

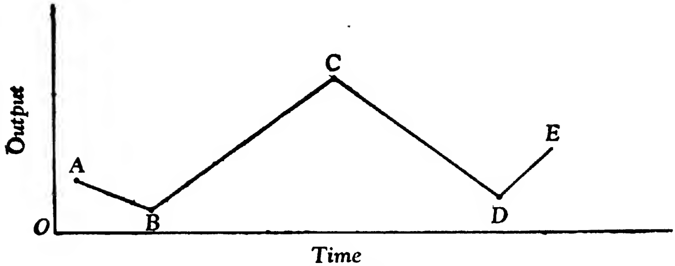
Although such assistance was sought by employers with the aim of increasing output and profit, psychologists soon evolved methods which led not only to an increase in efficiency in industry but to much better working conditions.

The problems dealt with include the avoidance of fatigue, and boredom, which is often mistaken for fatigue; the provision of effective incentives to work; the remedying of such defects, obvious though often overlooked, as insufficient or badly placed lights, imperfect ventilation and unsuitable temperature; the prevention of awkward and tiring postures caused by ill-designed working benches and by bad layout of tools and materials.

Exact study of the motions made by a worker in a process leads to the elimination of angular and unnecessary movements. The causes of unrest and irritation, and defects in organization, are investigated; and valuable advice in the choice of a vocation and in the selection of workers for jobs is given.

Problem of Fatigue

The first investigation in this fruitful application of psychology concerned fatigue. As the most obvious indication of the onset of fatigue is a fall in the rate of output of work, variation in output is a convenient index of fatigue. This interest in the worker's output



OUTPUT OF WORK GRAPH

Here is a typical graph showing output of work. AB indicates the slight fall in rate caused by settling down to the task; BC, increased rate of output as the workers warm up; CD, falling output due to the effect of fatigue; DE, final spurt due to the fact that the end of the work period is in sight.

often leads to the criticism that the psychologist's chief aim is to increase output for the benefit of the employer. In fact, for the psychologist output is a mere indicator, his primary concern is with human beings, the workers.

The criticism we have mentioned, however, is a reminder that the psychologist, before beginning an investigation, must obtain the confidence and co-operation of the workers. Their adhesion will not be forthcoming unless they are convinced that their interests are safeguarded, and that the investigation is not an attempt to benefit the employer at their expense, but aims at improving their conditions. In practice, of course, both employers and employed benefit.

The work curve is a graph constructed by plotting the amount of production against equal intervals of time during the working day. A reference to the above diagram (a normal work graph) shows that the graph begins by falling slightly, as workers settle down, then rises, showing the increased rate of output at the start of the day as the workers warm up to their task. The graph then falls, showing the increasing effect of fatigue. At the end of the graph there is often a rise showing that the workers spurt in realization that the end of the work period is in sight.

By expert interpretation of a work curve and by comparison of curves for the same kind of work done under varying conditions, valuable information is obtained.

A good curve should not slope too steeply towards the end, as this would show that the workers were tiring too rapidly. The increase or decrease of fatigue as between two working periods is thus shown by the alteration in shape of the curve, while increase or decrease in output is shown by the difference in

level of the two curves. A curve, for instance, may begin at twenty units per hour output, rise to a maximum of thirty units per hour, and slope away gradually to fifteen units per hour.

If, as a result of giving the workers a rest period half-way through the working period, a fresh work curve of the same shape as the first is obtained, but which begins at twenty-five units per hour, rises to thirty-five units, and falls away to twenty units, the effect has been to increase output without increasing fatigue.

Value of Rest Periods

If, however, a new plan, say an increase in piece rates, results in the second curve being at a higher level than the first but of a worse shape, having a steeper slope toward the end, output has been increased but so has fatigue.

If two work curves are on the same level but the second shape is better than the first, then the same output as before is reached with less fatigue; and if the second curve is both at a higher level and is of better shape than the first, then output has increased, and fatigue has diminished.

As a night's rest, and to a lesser extent a break for meals, effect recovery from fatigue, psychologists investigate the results of interpolating short rest periods in the working spell and of shortening hours of labour. It has thus been found that rest periods during the working day delay the onset of, and hasten recovery from, fatigue and increase output.

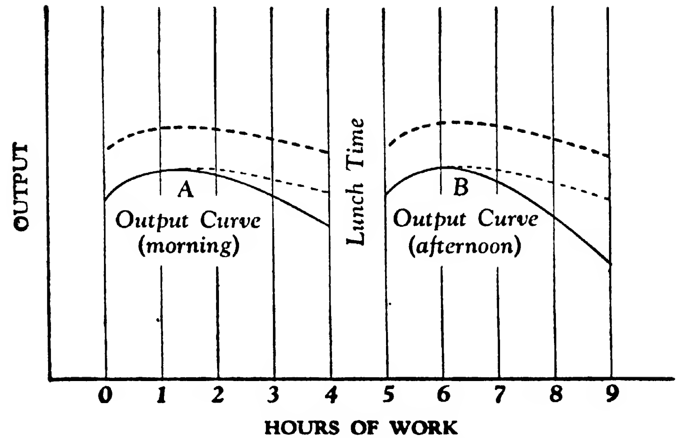
The rest should be taken just before output begins to decrease, in other words, just before the work curve begins to fall. The number and length of rest pauses suitable to any particular kind of work are found by trial.

These results cannot be applied to work of a different kind, but in each case a fresh test must be made. It has been found, for example, that output of mental work has been increased following the insertion of a pause of a few minutes every forty or sixty minutes, but that in some kinds of heavy physical work output is improved even if the workers rest for one half or even more of each hour.

When pauses are properly authorized by the employer the increase in output may be as much as four or five times greater than the increase occasioned by resting on the sly. The institution of the rest period is an excellent example of the benefit both to employers and employed by acting on the findings of industrial psychology. Not only does the employer benefit by increased output but the workers are happier, less fatigued, sustain fewer accidents, and are less often absent through illness.

Hours of Labour

The problem of rest pauses is closely related to that of hours of labour. As long ago as 1893 the hours of labour in a Manchester engineering works were reduced



EFFECT OF REST PAUSES ON OUTPUT

The value of rest periods is illustrated by the above graph, based on results obtained at a large factory. The morning and afternoon output curves (continuous lines) rose to a maximum at A and B and then fell as a result of fatigue (earlier and more steeply in the afternoon). Rest pauses at A and B delayed the fall (fine dotted lines). When rest pauses had become a routine, the curves started higher and were sustained (heavy dotted lines).

from fifty-three to forty-eight, and output increased as a result.

Subsequent research in industry under peace-time and war-time conditions shows quite clearly that reduction of hours of labour, within limits, and over a period, leads to increased output; and that hours of labour exceeding about eight per day are uneconomic.

Of course, short spurts with longer hours will yield a temporary increase, but the spurt must be short. With close mental work, the best results are obtained only if the working day is shorter still.

Reduction of hours also means a decrease in time lost by sickness, and by lateness and other unauthorized absence; and also a decrease in accidents and spoiled work.

As a result of the work of the industrial psychologist, there has been an increasing realization that the worker is a human being, not a mere hand or cipher.

Industrial relations, whether between trade unions and associations of employers, or between individuals within the factory, depend upon the instincts, sentiments and aspirations of human beings.

All his instincts at various times influence a man's behaviour in his work, but four or five play a very prominent part. One, the instinct

of acquisition, sometimes mistakenly regarded as the sole motive for toil, underlies the incentive for gain; but it is generally the servant of other impulses. A man desires higher wages, not from mere acquisitiveness, but as a means to purchase additional comforts and interests both for himself and for his family.

Self-assertion and self-display greatly influence a worker's behaviour. This instinct may lead a man to identify himself with his job, and even with a particular machine; and discontent is sometimes caused by transferring a worker away from *his* machine or *his* bench. The craftsman satisfies this impulse to an exceptional degree, but it is only slightly stimulated in those engaged in monotonous repetition work unless the rivalry impulse is encouraged in competitive output.

In general, if a man can be influenced to regard the work as his work, not merely the employer's, whether by profit-sharing schemes or by the motive of public service, this power instinct is satisfied and the worker is far happier and consequently more efficient.

The instinct sometimes shows itself in an undue love of prominence and a desire to domineer, and the industrial psychologist sometimes has to point out the bad effect of a domineering foreman on the efficiency and good relations in a factory. As distinct from mere domineering, we have the qualities of real leadership, and study of these qualities is an important duty of the investigator.

The gregarious impulse shows itself in the group spirit, the cultivation of which by welfare work, encouragement of clubs and benefit schemes, is sought by enlightened employers. The huge modern undertakings controlled by large companies, with their impersonal dealings, are under a disadvantage in encouraging *esprit de corps*, compared with the business in which the employer is in constant personal touch with his workers.

The pugnacious or aggressive impulse of the worker, with its emotion of anger, will be aroused if an undertaking is marred by friction and cross-purposes; and it is the aim of the industrial psychologist to suggest ways of avoiding frustrations which provoke irritation and anger.

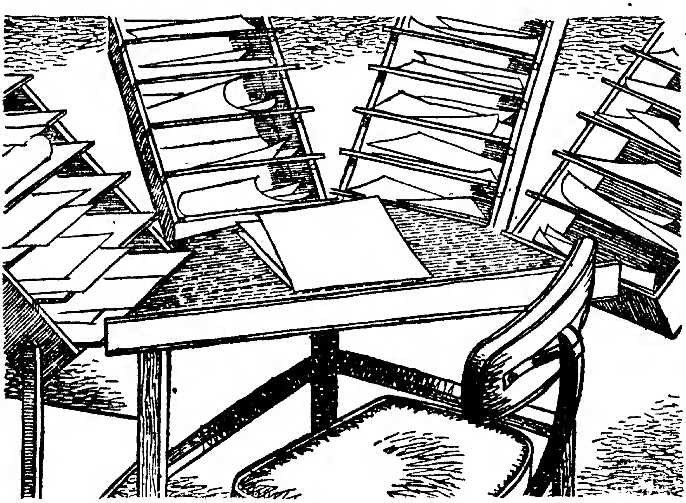
Improved Working Methods

Remarkable improvements in output, and decrease in fatigue and irritation, have been effected by changes in the layout of tools and materials. In sorting correspondence, the rearrangement shown in the illustrations on page 237 resulted in an increase of 33 per cent in the speed of sorting.

At first, a flat file, with its compartments lettered alphabetically, was used. The file lay on the table on which were the letters to be sorted. This type of file was replaced by four boxes, each divided into several compartments, and arranged in a semicircle above

IMPROVEMENT IN OUTPUT

The above illustration shows the laborious method of filing described in the text, and the illustration below, the rearrangement which resulted in an increase of approximately 33 per cent in the speed of sorting letters.



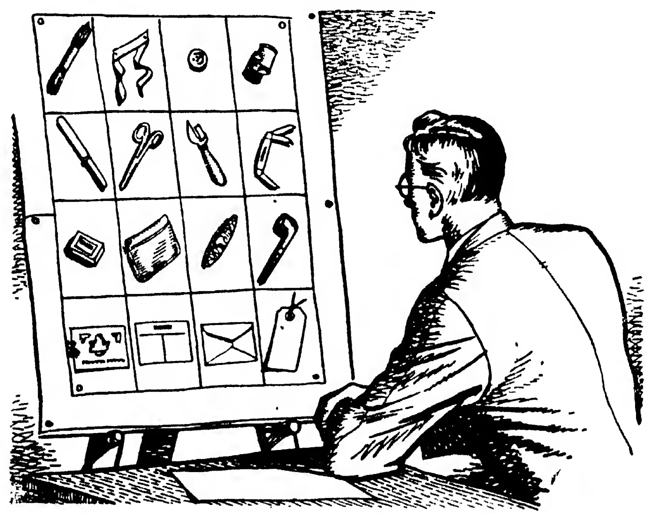
the level of the table, which thus had a clear space in front for unsorted letters. The boxes were tilted at an angle of forty-five degrees and their openings faced the clerk; while the compartments were lettered and arranged in such a way that those easiest to reach were those most often used.

Vocational selection and guidance is a very valuable application of industrial psychology. Advice is given to those selecting applicants for positions, and to applicants requiring guidance in choosing careers best suited to their abilities and aptitudes.

In both selection and guidance a sound knowledge of the requirements of a particular job is required, but in vocational guidance the psychologist is mainly concerned with the make-up of the individual who is being tested.

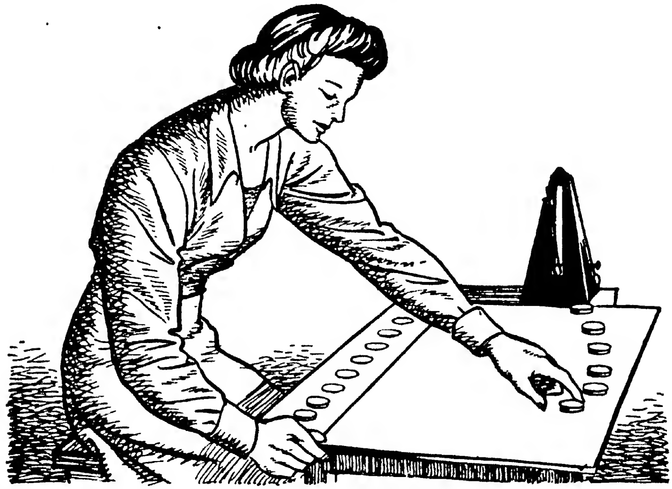
His intelligence, or more exactly, general mental ability, as already described, is therefore tested, as vocations range from the highest professional and administrative type of work, through clerical and skilled work, to unskilled and casual labour.

In addition, memory is tested, and the individual is examined for special skills such as musical and mathematical ability, for skill in



MEMORY TEST FOR SALESMAN

After having studied the board for half a minute, the applicant is later required to record from memory the position of the various articles, each row representing goods from a particular department of a large stores.



TEST OF MANUAL DEXTERITY

In this test for a packer, the applicant picks up the wooden disks one by one, keeping time with the metronome, and places them in circular outlines. Proficiency in this test will indicate accuracy and quickness in placing.

the use of words, for linguistic ability, mechanical ability and manual dexterity.

There remain further qualities which may be even more important in fitting a round peg into a round hole. These are qualities of temperament and character. Tests for these are much less reliable than intelligence tests, and in fact the most satisfactory technique is that of personal interview.

An expert in observing the way the subject answers questions and attacks his tasks learns a great deal about him; whether he is impulsive, or cautious and deliberate, whether he goes to pieces after having made a mistake, whether he perseveres or gives up readily in face of difficulties, whether he is timid or daring.

Qualities which are emotional and concerned with human relationships—such as sociability, timidity, self-assertion and submission—can be more easily assessed than such tendencies as curiosity and acquisitiveness. Moral qualities such as honesty, truthfulness, trustworthiness, are difficult to measure at an interview.

Experts in vocational guidance have already shown that if their methods replace the usual lack of method in choosing a career, much waste of ability, unhappiness and frustration will be avoided. Such

was the good fortune of a boy who ardently desired to become an engineer because he was so interested in machines.

Before making a final choice, his father wisely took the advice of a psychologist and it was found that the boy was not, in fact, in the least fitted for such a career. This was shown by his absolute failure at tests of mechanical aptitude. He was, however, very interested in travelling, and had a pleasing personality which enabled him to get on well with people.

He was advised to become a commercial traveller, a position which he filled with satisfaction to himself and to his firm. His interest in machines was nothing more than an interest in railway engines as a means of transport to the many places he wanted to visit!

Psychology and Criminology

Psychology is of great value not only in the study of criminology but in its practical application in modern courts of law. The psychologist tries to understand the criminal; he is not concerned with his apprehension and punishment, but rather with the explanation of his wrongdoing.

This often involves personal and social factors which are ignored by the strict legalist, but which lead the psychologist to the conclusion that many delinquents should be sent, not to prison, but to the clinic for remedial treatment.

The traditional view that criminals are especially wicked men and women who of set purpose choose wrong rather than right is a much too simple explanation. To a short-sighted policeman or magistrate a drunkard and an alcoholic merit similar treatment; they are both "drunks." But the psychologist points out that a drunkard wants to get drunk, the alcoholic does not—in fact may dread the effect of indulgence—but is overcome by an irresistible craving.

Causes of Crime

The view was formerly held, particularly on the Continent, that there is a criminal type, a kind of sub-human species, with distinguishing physical characteristics; but the results of further research do not support this view.

Individuals who follow a life of crime, who are always in and out of jail, are not doomed to a criminal career because of their physical or mental type. Force of circumstances and environment, unwise committal to prison in their youth, doubtless have helped to bring them to their present plight, but these factors are remediable.

Until recent years, it was within only narrow limits that persons were excused in law from criminal liability on the grounds that they were not responsible for their actions. The court had to be satisfied that the accused was insane, that is, at the time the alleged criminal act was committed, he was suffering from such a defect of reason as not to know the nature and quality of the act he was

committing, or if he did know, to be unaware that it was wrong.

In general this is still the law, but if the doctrine were rigidly applied, then no person whose wrongdoing is due to a pathological cause would escape conviction; but as the teaching of psychology has influenced the law, the courts, instead of punishment, frequently prescribe treatment of the psychological factors causing the crime. Sexual offenders, for example, are nowadays often bound over to receive psychological treatment instead of being sent to prison.

Crimes due to Repressed Impulses

Perhaps kleptomania is the best known of the pathological causes of crime. The kleptomaniac takes articles he does not need, and it is quite clear that he suffers from a compulsive tendency to steal. This is sometimes due to repressed sex impulse manifesting itself in an irresistible urge to collect articles belonging to persons of the opposite sex. Repressed sex impulse may also be the cause of such offences as ink throwing and slashing women's dresses with razors.

Extreme pugnacity and recklessness may be caused by repressed fear; and repressed self-assertion may cause morbid cruelty or sadism with resulting crimes of violence. Some cases of arson are due to a compulsive mania for fire-making.

Psychology is slowly influencing the criminal law and has succeeded in diminishing the number of cases in which blind punishment is imposed on a morally sick man or woman, when treatment, not prison, is the appropriate remedy.

The important question of the value of human testimony has long interested psychologists and they have established that the matter is much more complicated than is often imagined. The law attempts to secure accuracy of testimony by means of the moral or coercive influence exercised by the administering of a solemn oath, or affirmation, and by the threat of prosecution for perjury. The witness is regarded as intending to give either true or false evidence; but this assumption is not wholly correct.

Psychological research shows clearly that accuracy of evidence depends upon many other factors besides the intention of the witness. With the best intentions in the world, a great deal of sworn testimony may be false. It is shown by experiment that on the average from 10 to 15 per cent of all sworn testimony is false in spite of the sincere intention of the witness to tell "the truth, the whole truth and nothing but the truth."

Giving Evidence

In giving testimony, a witness puts into words what he can recall of the results of his attention and observation. His evidence must be first hand; hearsay evidence is not admitted except in very special circumstances. Attention, observation, retention and recall are thus involved, and, in addition, the ability to present his report so as

to convey to the hearer an accurate impression of the experience.

Leaving out of account a deliberate intention to mislead, the worth of the evidence depends on the efficiency of the four factors mentioned and on other factors, such as lack of care, suggestibility and imperfect knowledge of the meaning of words. Perhaps the day will come when witnesses will be tested for these factors before they are allowed to give evidence.

Inaccuracy in Evidence

As a result of a long series of experiments in the laboratory, in which subjects have testified sometimes in writing and sometimes orally, certain facts emerge. It is found, for instance, that even when a competent subject is reporting under favourable conditions, a report free from error is the exception and not the rule; over 95 per cent of such reports are inaccurate in some particulars.

A witness's age and intelligence affect his accuracy; within limits fidelity of testimony increases with age, and the more intelligent a witness is, the more accurate his evidence is likely to be. This is subject to the reservation that intelligence plays a smaller part in testimony on long past events.

Inaccuracy in evidence can often be traced to the suggestibility of the witness. Although he thinks his testimony is based on observation and reasoning, it may in fact be based on impressions acquired by suggestion. By suggestion we are induced to accept ideas and beliefs without having logical reasons for so doing. We become convinced by the words or actions of the person or group making the suggestion, although no arguments are advanced. In auto-suggestion the suggestion is both offered and received by the self.

Suggestion, then, is a process whereby a person becomes convinced of the truth of a proposition in the absence of real evidence to support it. It even has a great influence on the body, as shown in Chapter Twelve (page 257).

The result of suggestion may be beneficial or harmful, depending upon the nature of the suggestion made; but in a court of law, when the establishing of certain facts is at issue, the extent to which a witness is suggestible profoundly affects the accuracy of his evidence.

Thus a witness's prejudices influence him to accept facts without logical reasons; this is recognized by the law when a trial which is likely to arouse strong local feeling is transferred to a district where the parties are unknown.

Factors in Suggestion

There are various factors which increase the effect of suggestion. If, for instance, the person receiving the suggestion is very young, or ignorant, or through fatigue, ill health, emotional stress, or the effect of drugs, is not mentally alert, he will easily accept suggestion.

Then if certain of the instinctive impulses are strongly stimulated,

suggestibility is increased. When we are very angry or afraid, we are ready to believe almost anything. The maternal impulse makes it easy for a mother to act on suggestion with regard to her own children.

Leading Questions

In the courts leading questions, that is, questions in which the answer is suggested in the question, are allowed only in cross-examination. It is recognized that to allow such questions in all examination would enable the questioner to get from most witnesses any answers he wanted. The allowing of leading questions in cross-examination may be justifiable in an attempt to discredit a witness, but any evidence obtained in cross-examination is of very doubtful value.

The word-association test, described in the section on medical psychology, has been used in an attempt to detect crime. A list of words, most of them neutral and having nothing to do with the crime, but also containing significant words directly connected with the crime, is read out to the suspect, one by one, and he is instructed to respond with the first word which comes to mind.

The responses to the significant words are carefully noted; a guilty man may unduly delay his replies to these incriminating words, or give as response a word which could only have been given by the real criminal.

Attempts have been made, with varying success, to detect guilt by noting the change in blood pressure, respiration rate and electrical resistance of the skin during the investigation of a crime. Emotion causes variations in the processes mentioned, and a guilty man may show his guilt by variations in the readings on the apparatus.

Unfortunately, innocent people, owing to nervousness, can show similar reactions, and this method of crime detection has not yet passed the experimental stage.

Our consideration of the contribution of psychology to criminology and law suggests that those who administer the law, with its profound effect on the welfare of human beings, can obtain valuable help in their task from those who are studying the complexities of human nature.

Medical Psychology

The use of psychology in the medical field is now widely accepted. Psychological treatment of "nerves," that is, of functional nervous disorders, is based on the methods of Freud the pioneer.

In treating hysterical and neurotic patients, Freud's problem was that of releasing the emotions pent up in the repressed complexes; and he discovered that release was frequently obtained if the patients discussed their troubles and were able to recall to mind the experience which first gave rise to the symptom.

Owing to unconscious resistance, attempts to recall were unsuccessful, but, in many cases, if appropriate

suggestions were made to the patient when under hypnosis, the repressed experience was recovered, the mind purged of its morbid material, and the cure effected.

Free Association Method

Hypnotism, which could not be induced in all cases, was soon discarded as a general method of treatment in favour of the method of "free association," in which the patient, when physically and mentally relaxed, is asked to think of his trouble and tell the physician everything which comes unbidden into the mind, however trivial, embarrassing or even repulsive.

The instruction is "tell me everything, especially the things you don't want to tell me." One thought calls up another, and as the control and censorship ordinarily exercised by the conscious mind are slackened, the unconscious takes charge and thoughts are directed, sooner or later, back to the original cause of the trouble.

The problem of the physician may, therefore, be stated as follows: to discover the complex, break it up, and free the instinctive emotions from their morbid attachments. Finally, the freed emotions are to be brought under the control of the will and used to serve the self.

In his quest the physician may be helped by various signs. The existence of a repressed complex may thus be indicated by irregularities of conduct, by physical symptoms, by defects of character, by dreams and by response to the word-association test. Complexes which a man refuses to admit he possesses may thus be shown in conduct by projection and objectification in which they are attached to persons and objects in the outside world.

He may for example, unjustly attribute to another faults which are his, but which he fails to see; he may make sweeping and undiscriminating condemnations of all and sundry and, in so doing, reveal not the weaknesses of others but his own. The cynic who proclaims that every man has his price is generally ready to be bought himself.

By this same process of projection a person may attach repressed fears of his own impulses to objects in the environment, and he may suffer, for instance, from a morbid fear of closed spaces.

A bad habit may be evidence of a repressed complex. Excessive irritation, or outbursts of bad temper when one is criticized, may be due to an absurd over-valuation of one's own capacities derived from unwise training as a child, which valuation was not surrendered but repressed when the hard adult world came to be faced.

Repressed Complex

It may be objected that there is a danger of undermining moral responsibility in admitting that defects of character, such as sex perversions, uncontrollable temper and cruelty may be due, not to deliberate choice, but to causes

over which the individual has little or no control; but it does appear that certain wrongdoing is undesired and uncontrollable and is due to a repressed complex.

Whether the individual was originally fully responsible for acts which initiated the progressive deterioration to his present deplorable state is another matter.

Dream Interpretation

Dreams often indicate complexes. Thus, a dream of the death of a person may be evidence of an unconscious wish to be rid of him. In endeavouring to interpret a dream the analyst asks the patient to think of what he saw in his dream and to tell him everything that comes to mind by free association. Dream interpretation, however, is an uncertain method and is never relied upon alone. Its findings must be corroborated by other methods. Different interpretations of the same dream will be given by different analysts. Some regard the symbols in dreams as sexual; to others they compensate for something lacking in the conscious life; others consider dream symbols to be images inherited from our primitive ancestors. They are also regarded as reminiscences of our own past; or as preparing for some problem in life.

The word-association test as a complex indicator was devised by Jung. The method consists in asking the patient to give as quickly as possible the first word which comes into his mind when the test word is called out. The time and manner of response are noted and the nature of the response word, also any physical signs of embarrassment, such as blushing, twitching, uneven pulse or breathing.

It is found that to the majority of words the time of response will be one second or less (children and adolescents are slower than adults); but that to certain words, the response is much delayed. This delay is only one, but is the most important, of the signs carefully noted by the physician.

Such signs include, in addition to the physical signs already referred to, hesitation; correcting a half-uttered word; a complete failure to give any word; avoiding the stimulus word, for example, by naming objects in the room, or by giving opposites or definitions.

Emotional Tensions

Any associations which disturb the subject's emotional tensions are accompanied by some of these signs. These tensions are not always genuine complexes, but include, in addition to the true repressed complex, any idea which arouses strong emotion, such as an idea which is part of a strong sentiment.

The signs may also indicate a conflict of emotion which is fully conscious but which the subject wishes to hide. For this reason the test has sometimes been used in an attempt to detect crime.

When the significant words have been found, that is, the words the

responses to which are accompanied by the signs referred to, they may be used as starting points for the free association process.

Starting the Treatment

Having noted any indications of the complex, the physician begins the treatment proper, the process of free association. This may start with the idea of the symptom, or with symbols from dreams, or from the significant words derived from the word-association test. The patient being in a quiescent state is asked to think of the idea: "origin of my symptom."

This arouses another idea, which in turn arouses another. Ideas are allowed to come to mind spontaneously without any restraint or criticism and without conscious endeavour on the part of the patient to remember.

In some cases it is found that the process is hastened if the patient is hypnotized and the suggestion made that the required memory will be recalled after coming out of the trance. Some practitioners adopt the practice of inducing drowsiness by the injection of drugs, under the influence of which the patient tends to talk freely of his intimate affairs.

As the analysis progresses, pictures of earlier and earlier occurrences of the symptom are called to mind, until, at last, the earliest is remembered.

When this first experience, say, being locked in a cupboard when a child, has been recalled, it is then necessary to discover what emotional conflicts accompanied it—say a fear of suffocation and death. This reliving of the original emotional experience, called by Freud, abreaction, releases the pent-up emotion which is the cause of the present trouble, and the patient experiences a remarkable feeling of relief.

Although abreaction may be sufficient to cure the symptom, the analysis must generally be continued to lay bare the complex which produced the original state of mind which caused the unhealthy response to the event. After all, most of us have shocks and unfortunate experiences in childhood without our necessarily becoming neurotics. This continued search is also carried out by means of free association.

Effecting the Cure

The cure can thus be summarized. Starting with the present symptom, say a hysterical backache, a tremor, or fear of pine trees, the origin of the symptom and the emotional conflict at the time are recalled to mind.

Next the repressed complex, the real cause both then and now of the symptom, is laid bare. This complex is then broken up, and the emotion is released and controlled by the will. For the cure to be consolidated the freed emotion should be linked up with some worthy purpose.

This procedure is illustrated by the experience of a professional

man suffering from terrible headaches, fits of depression and bad temper, and unreasoning resentment of any criticism of his work.

An event in boyhood was recalled when he saw a man lying in the road bleeding from the head. He witnessed this unpleasant sight when hurrying to post a most urgent and important letter for his father. Oblivious of time, he watched with fascinated horror the rendering of first aid, and as a result of his delay lost the post.

Repression of Painful Incident

On his return home he was subjected to a violent tirade from his father, who bitterly and sarcastically reproached him for slackness and general inefficiency. He felt somehow that he could not reveal the cause of the delay as he was so angered and humiliated by his father's harsh and unjust attack. He later repressed the whole painful occurrence.

Recovery of the event cured his headaches, but further analysis was necessary to discover the complex which was still causing his depression and bad temper and his absurd touchiness.

At length this was laid bare. For years he had been an only child, spoiled and the very centre of the home, shown off by doting parents as a prodigy. Then brothers and sisters were born and he was supplanted and placed on the shelf. His exaggerated self-assertive impulse was now painfully thwarted by his new feeling of inferiority and insignificance; and he acquired the habit of brooding over the many slights, real and imaginary, placed upon him. He felt that nothing that he did found favour, and he became excessively sensitive to any criticism or blame.

This complex of anger, thwarted self-assertion, and inferiority was repressed and was the cause of the symptoms in adult life.

When he realized the part played by the complex in his present psychology he saw clearly that his depression, bad temper and unreasoning resentment of criticism always occurred when he had been careless and had shirked responsibility in his professional work. This neglect he had been unwilling hitherto to admit to himself, but now that self-revelation was complete the cure was accomplished.

Systems of Analysis

A comparison between the system of Freud the pioneer, and those of Jung and Adler, both former disciples of Freud, shows that Jung, while not omitting to unearth the patient's past, is much more insistent than is Freud in examining the present situation to find how the patient is failing to meet life's demands. Bad complexes arising from the child's failure to adapt himself to life do not lead to a breakdown in the adult unless some situation overwhelms him.

Starting with the individual's present trouble, Jung, using the methods of free association, word association, and dream analysis

attempts to discover, not only the sources of the trouble in childhood, but the patient's unconscious attitude to his present problem. When these discoveries have been made, the patient is encouraged to endeavour to rebuild his life for the future; and in this process the important part played by religion and ideals in general is always stressed.

Jung, in his *Modern Man in Search of a Soul*, states that during thirty years' practice as a psychotherapist he has not had one of his patients over thirty-five years of age whose problem in the last resort had not been that of finding a religious outlook on life; and he adds that neuroses grow more frequent as religious life declines.

Adler in his treatment seeks the life-style and family-style of the child. These will be indicated by his position in the family, whether he was, for instance, the only child, the eldest or youngest child.

Finding a Life-goal

The life-goal which the individual has set himself, the failure to achieve which has led to the breakdown, must also be discovered. This may be revealed by his general interests, his likes and dislikes; or the characters in history or fiction he regards as heroes. Adler, too, encourages the patient to plan his life in relation to worth-while goals.

Although there are many differences between curative methods there are fundamental points of agreement. All methods look to the early years of life for the origin of the symptoms.

In each, as might be expected, the personality of the physician is of great importance; the patient develops an emotional attitude toward him. Sometimes it even seems that the released emotions, be they of love or hate, fear or anger, are temporarily transferred to the analyst; but the attitude is generally one of confidence and one which involves a large element of suggestion. The prestige of the physician powerfully backs his curative suggestions.

Value of Relaxation

Again, in all methods, the patient is instructed to relax completely; and complete relaxation is itself a very valuable curative process. It almost inevitably induces deep and rhythmical breathing which is most beneficial. In fact many physicians instruct patients to breathe slowly and deeply during relaxation. Breathing is the only vital function concerned with growth and nutrition which we can control directly by an effort of will.

All these vital functions are intimately connected, so that, by controlling breathing, control is indirectly exercised over such processes as those of the ductless glands, which are closely concerned with the mysterious relationship between body and mind. Curative suggestions accepted during physical relaxation and deep breathing therefore influence these organs; body and mind are both benefited.

CHAPTER TWELVE

THE UNCONSCIOUS MIND

Freud's theory of the unconscious mind. Psycho-analysis. Conflict within the self. Wish-fulfilment and neuroses. Meaning of dreams. Discovery of cause of neurotic symptoms. The id, ego and super-ego. Effect of feeling of inferiority. Neurotic reaction. Curing a neurosis. Introverts and extroverts.

THE "unconscious" or the "unconscious mind" generally indicates certain very active processes which remain unconscious in spite of their energy, and in spite of efforts of will or acts of memory to bring them into the light of day.

The unconscious mind is, of course, only a theory; being unconscious we cannot know it; but remarkable results have been obtained in the treatment of mental disorders by assuming that the unconscious mind is a fact. We infer the existence of the unconscious mind from our observations and deductions. Most people have had the experience of going to sleep with a problem unsolved, and of waking up to find that the solution flashes to mind. In the present state of our knowledge, we explain it by saying that the unconscious mind worked on the problem.

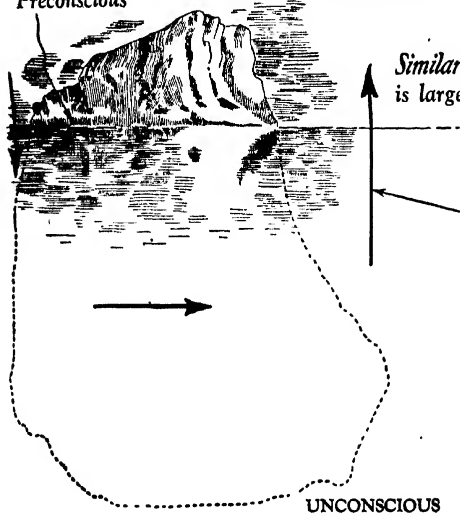
Influence on Conscious Thought

We attempt to describe the unconscious mind by analogy. The mind has been likened to a great ocean, the bright surface of which represents the conscious mind, and the dark and much larger volume of water underneath the unconscious. The lower layers of water are constantly rising to the surface under the influence of differences in temperature, and, therefore, change the temperature and content of the surface. Similarly, the unconscious mind continually modifies and influences our conscious thought and actions.

Unconscious Memories

Freud's theory of the unconscious, which grew out of his study of nervous disorders, repudiated the academic psychology of the nineteenth century with its emphasis on consciousness. He found that his patients had memories, strongly charged with emotion, of which they were wholly unconscious. He also found that, although the patient consciously desired to revive the memory, there seemed to be a definite resistance (the repression) preventing its entry into the light of day. This resistance was beyond the control of the will.

A man suffered from fits of unreasoning fury against any wearer of white spats. Analysis showed that an event, all conscious memory of which had gone, was still



MIND COMPARED TO AN ICEBERG

The part of the iceberg above the surface represents the conscious mind, and the far larger submerged part, the unconscious mind. At the water line is the preconscious. Water round the iceberg represents the interchange of ideas.

imprisoned in the unconscious. When the resistance was overcome, an experience of many years before was recalled in which a man wearing white spats had insulted and humiliated the patient. The painful experience would not bear thinking about and was, therefore, relegated to the unconscious; it continued, however, to affect the conscious life.

In strictness, the term psychoanalysis should be used only for Freud's doctrine. Freud's main assumptions are: that all conduct, even if accidental, is the expression of a motive, and often of unconscious wishes; that situations and desires once experienced live on in the individual, and even if forgotten or unconscious, continue to influence the present; that mental processes exhibit polarity, or pairs of opposites: the conscious and the unconscious; the ego and the libido; the life urge and the death urge.

On the whole, Freud's frankness in dealing with the problem of sex, has encouraged a more healthy attitude toward personal problems.

His theory of repression threw new light on mental conflict. Before Freud, psychologists had spoken of conflict between the self and the

environment; but a repression is a conflict within the self. This conflict is the cause of the neurosis. Freud thus made the then astonishing assertion that mental diseases may have mental causes.

Freud's Three Assumptions

In building up the superstructure of psycho-analytic theory, Freud makes the three great assumptions to which reference has been already made: motivation and persistent complexes; the effect of the past; polarity or dualism.

For Freud all conduct is the expression of a motive, that is, is wish-fulfilling. This is obvious in voluntary action, but actions which are involuntary, accidental, and even contrary to the intention of the individual, are, according to Freud, in fulfilment of wishes. A neurosis, distressing as it is, is desired by a part of the personality.

For example, a young woman suffered from paralysis of the legs for which there was no assignable physical cause. A year or so before, when nursing her father through a long illness, she frequently had to lift him and, in so doing, threw a strain upon her legs. Her feelings were complicated at the time by her desire to marry. The only factor delaying the wedding was her father's unfortunate illness. Although she was a truly devoted daughter, she could not help wishing that his illness would end one way or another.

This desire, although very strong, was rejected with horror; mentally she ran away from it, later repressed it, that is, deluded herself that it did not exist. But it persisted and was still active in the unconscious, and the desire whioh was so repugnant found a fulfilment in the paralysis of the legs. The paralysis fulfilled her wish to escape from an intolerable situation of mental conflict; she was now free from the responsibility of nursing her father.

Dr. Hadfield reports a case which also exemplifies this principle. A lady emphatically protested to him that she and her husband were a most devoted couple; but to the physician it was obvious that the contrary was the truth.

Four apparently unimportant signs revealed her hidden motives: she intended to meet the train by which her husband was returning after a week's absence, but forgot to do so; she dreamt that some harm had befallen him; she had the habit of unconsciously moving her wedding ring on and off her finger as she talked; she was too emphatic and persistent in protesting her devotion for her husband.

Hidden Motives Revealed

The first sign showed her indifference. Repressed wishes determined the second and third, while the fourth was an attempt to hide her true feelings. The diagnosis was confirmed and the lady faced the real truth: that she was in love with another man.

Freud, in his *Psycho-pathology of Everyday Life*, insists that so called trivial lapses, slips of the tongue,

forgettings and the like, are not mere accidents but are unconsciously motivated.

Freud analysed himself when he could not recall the name of one of his patients whom he had treated for a very long time. It happened that Freud had wrongly diagnosed the patient's condition and treated her for neurosis when, in fact, she was suffering from ulcer of the stomach. This is the kind of case a physician would like to forget and Freud concluded that for this reason he had erased her name from his memory.

It is suggested that most mistakes in writing the date are motivated. If we are eagerly looking forward to some pleasant experience next month we may mistakenly insert next month when writing the date.

Wish-fulfilling Dreams

Even dreams, with their jumble of strange experiences, are regarded as wish-fulfilling. Some dreams, particularly children's, are obviously the expression of a wish. A slum child will dream of sumptuous meals; but a well-fed boy, not allowed much freedom, will dream of glorious freedom as a pirate or Red Indian. In most adult dreams the wishes are repressed, although even adult dreams are sometimes obvious. For example, explorers, on short rations, report dreams of luxurious meals.

The second great assumption made by Freud is that the individual's present psychology depends on the early years of childhood. This means far more than the truism that what happens to us in childhood leaves effects behind. It means that shocks, events, wishes in childhood, live on in the individual. The causes of present dreams, lapses and neurosis are thus found in the past.

Morbid Associations

A man had never been able to take milk as long as he could remember. On analysis, it was discovered that at the age of three he was given a powder in milk which was too horrible to swallow. At the sixth attempt the doctor, by force, kept his mouth closed. He choked and was nearly suffocated.

The taste of milk and powder was, therefore, associated in his mind with this terrifying experience, and although the incident was forgotten the association between milk and terror remained, and he found it impossible to take milk. At length, twenty-five years after the incident, analysis laid bare the morbid associations and their power was broken. Before he left the room he enjoyed a glass of milk and remarked: "It does not taste like milk at all."

The daily succession of ordinary influences in childhood, the suggestions received, are more important than one particular event. Abnormality of mind is determined more frequently by atmosphere than by shock. Whatever the cause, no immediate ill effects may appear; the complex may remain quiet until later in life, when the individual

breaks down in a difficult situation which a normal person would meet in a healthy fashion.

Most psycho-therapists, whether followers of Freud or not, believe that all functional nervous disorders, even if occurring in later life, in the teens, the thirties or in middle age, originate in childhood. In treatment attempts are, therefore, made to trace back the neurotic symptom to childhood.

Tracing Cause of Symptoms

A man's symptom, for example, may be lack of will power and an inability to work. Laziness is not the cause; a deeper search must be made. It is learned that as a child he had a very strong craving for praise; he could not bear to be criticized. He also had a very severe mother who set an impossibly high standard; the stage was set for conflict. He could not earn the praise he so much desired from such a mother. She blamed him for all he tried to do, and he became afraid of doing anything. He said: "Rather than risk doing wrong and suffering her displeasure, I'll do nothing." That childhood attitude persists; he is still abnormally desirous of praise; he is still terribly afraid of making a mistake. He therefore suffers from an inability to make up his mind to do anything.

Freud's third assumption is that our mental processes show polarity or dualism. His pairs of opposites have been already mentioned and the first and most obvious, the conscious and the unconscious, has been discussed. The next is the ego and the libido or more recently the ego and the id. According to psycho-analysis, there are three agencies in our mental life.

The first is the unconscious id, the deepest part of the mind, the reservoir of instinctive impulses; its ruling principle is a blind seeking after pleasure (pleasure principle).

The second agency is the ego. This word ordinarily means the individual's conception of himself; but in psycho-analysis the ego is that part of the id which has been moulded by the impact of the external world through the senses. It is imbued with consciousness (but is not fully conscious, as it is in contact with the id), and its functions are to control and select the wishes and demands of the id in the light of the realities of the external world. The ego is, therefore, determined by the reality principle. To use Freud's own words: "The ego tries to mediate between the world and the id, to make the id comply with the world's demands, and by means of muscular activity, to accommodate the world to the id's desires." The id clamours for sensuous gratification according to the pleasure principle but the ego applies the reality principle.

Influence of Super-ego

This thrust and counter-thrust of the ego and the id is influenced by a third agency, the super-ego or the ego-ideal, which corresponds roughly to conscience. It is regarded as a standard of conduct

formed when the child identified himself with admired persons. The super-ego rules the ego, it is the moral critic which produces anxiety, distress and feelings of guilt in the ego whenever it gives way to the id.

The ego is frequently hard pressed in its attempts to reconcile the three lots of conflicting claims: those of the id, the super-ego and the outside world. In mediating between the id and reality it must clothe the crude demands of the id in respectability, must gloss over the bitter differences between the two. While this is going on the stern super-ego is watching, relentlessly holding up standards of behaviour; and if they are ignored the ego is punished by feelings of guilt and inferiority. The development of the super-ego in relation to the Oedipus Complex is dealt with in the next chapter.

The third pair of opposites is the life urge, or Eros, and the death urge. Death, being the end of life, is regarded by Freud as the goal of an urge he calls the death instinct. The longing for rest or Nirvana, and the suicidal tendencies of some people are considered to be expressions of the instinct. The term has been extended to cover all forms of destructiveness and cruelty.

Feeling of Inferiority

The feeling of inferiority is very painful. The individual feels it cannot be tolerated because he has a fundamental will for power, an urge towards mastery. He must make himself superior in some way, or at least delude himself and others that he is superior.

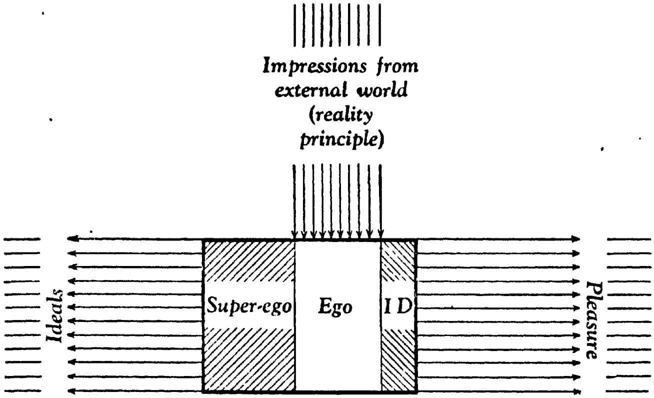
Adler teaches that there can be three responses to the feeling of inferiority: successful compensation; defeat and retreat; or a neurotic reaction.

Successful Compensation

We have already cited the striking example of compensation in the case of Demosthenes. Beethoven was slightly deaf in childhood, an affliction which increased in after years. The first President Roosevelt overcame his frail physique by life in the open air. He became a "rough rider" and explorer. Many a man owes his success in life to a disability which required great effort to overcome. As Burke said: "He who wrestles with us sharpens our skill; our antagonist is our helper." Often the successful compensation side-tracks the inferiority entirely, as, for example, when a boy, weak physically, becomes a brilliant scholar.

Where the response is defeat and retreat the individual regards his case as hopeless. He generally arouses sympathy; he is regarded as a helpless victim of his weakness.

The individual whose reaction is a neurotic one compromises by justifying all his failures and pointing to his limitations. According to Adler, the neurotic says: "If I were not so anxious, if I were not so ill, I should be able to do as well as the others. If my life were not full of terrible difficulties I should be the first." He thus achieves a



RELATION OF ID, EGO AND SUPER-EGO

This illustration shows in diagram form the conflicting claims of the id, ego and super-ego. The id is the seat of instinctive impulses and is guided by the pleasure principle. The ego is moulded from the id by the impact of the external world and is thus determined by the reality principle (see page 253). In trying to reconcile these two principles, the ego is influenced by the super-ego, which holds up standards of behaviour based on ideals. Neglect of these very important standards brings feelings of guilt and inferiority.

feeling of superiority, but he pays for this with his neurosis. Sometimes the neurotic sets himself an impossible goal, and rather than admit to himself that he cannot achieve it, he breaks down, and perhaps arouses sympathy.

The neurotic reaction frequently takes the form of over-compensation. By analogy with a short man, who often compensates for his lack of inches by being very pushing and assertive, the neurotic may over-compensate for his painful feeling of inferiority by aggressive conduct.

Adler in treating a neurosis endeavours to discover the patient's "life style." This style of life is adopted in childhood and, broadly speaking, remains throughout life. As a result, each individual has a typical goal toward which he will strive in all situations. The life style is not determined by heredity but by home life in early years.

Adler does not deny the importance of the sex impulse, but holds the view that it serves the great fundamental urge to superiority.

After many years as a disciple of Freud, Jung came to regard the doctrines of psycho-analysis as needing expansion in three important respects: the nature of the unconscious; the neurosis; and the libido. For Jung, the unconscious

includes, not only the personal unconscious, but the racial unconscious. The personal unconscious includes material repressed, material forgotten and material which is acquired unconsciously.

Inherited Ways of Thinking

The collective or racial unconscious is inherited, and consists of instincts, that is, primitive ways of acting; and primordial ideas or archetypes, that is, primitive ways of thinking. It is suggested that we inherit not definite ideas, but certain ways of thinking, and that when we are off our guard we tend to think with primitive man.

In Jung's view the unconscious compensates for the conscious. Qualities which are strong in the conscious life are weak in the unconscious; and vice versa. A man timid in his conscious life is very brave in the unconscious. Timid and puny persons tend to have dreams in which they perform great exploits of daring. The unconscious contains both noble and base material which has been excluded from the conscious, so it has been well said that a man is both better and worse than he believes himself to be.

With regard to the neurosis, Jung, while admitting the important effects of the early years, goes beyond Freud's ideas and asks what is the present situation which is arousing the trouble which has lain dormant for so long. He says: "I no longer find the cause of the neurosis in the past, but in the present. I ask what is the necessary task which the patient will not accomplish."

In analysing a young man's dream of his mother, whom Freud would probably regard as symbolic of the man's infantile sexual desires, Jung ascertained the present situation and found that the mother suggested neglect of present duties. The young man in fact had been unable to decide on an occupation and had broken down. For many years he had neglected his mother and she, in his dream, was a symbol of his general neglect.

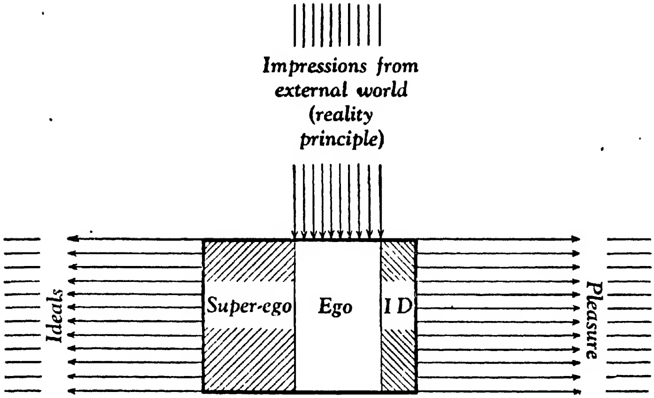
Jung extends the meaning of the libido. It is a great general urge, an all-embracing vital impulse. Like physical energy, which has several interchangeable forms such as heat, light, and electricity, so the libido shows itself in various instinctive activities. The sex, the assertive and other instincts are manifestations of the one vital urge.

Jung regards this energy as striving toward a goal, toward equilibrium; and he therefore aims to cure a neurosis by helping the patient to direct his energy toward a healthy goal, so as to reach the equilibrium which the neurosis is a subconscious attempt to attain.

Extrovert and Introvert

Jung originally described two types of individual, the extrovert, or feeling type, and the introvert, or thinking type.

The extreme extrovert is essentially a man of action interested in the objective; the extreme introvert



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CHAPTER THIRTEEN

REPRESSIONS AND COMPLEXES

Meaning of complex. Formation of sentiments. Difference between repression and self-control. Sexual instinct in childhood. Three phases of early sexual development. Attachment of child to parent of opposite sex. Ego-ideal, or conscience. Types of neuroses. Inferiority complex. Overcoming a complex.

THESE terms, like many others in psychology, are frequently used loosely, and it is, therefore, desirable to begin by defining them exactly.

The word complex comes from a Latin word meaning embrace, and a complex is a closely connected group of ideas and emotions which acts as a unit.

Our instinctive emotions in childhood form groups around various objects, persons, events or ideas. Generally, the first of such groups formed by a child is around the idea of his mother. The sight of mother, or the thought of her, arouses a blend of impulses which increase in complexity as the child grows older. Obviously the food-seeking tendency is the first aroused, but later submission, assertion, fear, curiosity, appeal and others become linked up, until a stable constellation, love of mother, is formed. Such constellations or sentiments are our acquired likings and dislikes, our loves and hates.

Complexes are constellations which have an unhealthy tinge, which are repugnant to the self and which tend to be more or less repressed. To have a complex means to deal in an unhealthy way with certain persons, objects or situations. The man who became unreasonably angry with any wearer of white spats (see page 249) had a complex in which the idea of white spats was linked with feelings of anger and humiliation. The complex was so unpleasant that it had been repressed.

A repressed complex being charged with energy sets up conflicts in the unconscious mind which affect the conscious life.

Repression must first be distinguished from suppression. We suppress an impulse when we endeavour to dismiss it from consciousness because it is abhorrent. It may be abhorrent because it is unpleasant, or because it arouses a feeling of guilt or because it is tabooed. The attempt at dismissal, if repeated often enough, may be quite successful; and the unpleasant ideas may be completely relegated to the unconscious, or in other words, repressed.

Repression is, therefore, an unconscious process by which the ideas which are painful to consciousness are forced into the unconscious; but they still remain

dynamic and burst forth in many unexpected ways, often disguised.

Repression must also be distinguished from self-control. A good everyday definition of a repression is—succeeding in deluding oneself that an impulse does not exist; but in self-control the impulse is admitted but is controlled and sublimated. Dr. Hadfield reports that a lady who was nursing during air raids suffered from an "anxiety" neurosis. But when she recognized that she was afraid, which until then she had refused to admit, her trouble disappeared. Her fear now recognized was easily controlled.

Breaking down Resistance

As the experiences which are repressed into the unconscious are painful ones, it naturally follows that there is a resistance to any attempts made to bring such experiences into the light of consciousness. This resistance is unconscious and continues in spite of the patient's earnest desire to co-operate with the analyst. To break down such resistance and liberate the repressed emotional energy is one of the chief aims of treatment.

We have seen that Freud describes repression as the main pillar of the edifice of psycho-analysis; and that the other great pillar is infantile sexuality. The assertion that the sexual instinct shows itself in childhood has aroused bitter hostility; but any understanding of psycho-analysis is impossible unless this fundamental conception is studied. For Freud, sexuality includes all forms of sensuous gratification. When, therefore, the infant sucks, or puts things into his mouth, he experiences a pleasure which is sexual. A similar gratification is given by rubbing, stroking or patting; and by the excretory functions.

Freud insists that the infant's gratification is in fact sexual. The thumb-sucking gives a genuine, though rudimentary, sex pleasure.

Freud thus controverts the old view that the sex impulse is latent from birth until adolescence. He teaches that it develops during the first five years of life, is then latent until puberty, when development continues.

There are thus two stages of sexual development, and the nature of the second period is largely determined by the first. The troubles of puberty, the nervous disorders of later life, cannot be understood and cured unless the course of development of the earliest years has been traced.

Three phases of this period are described: the oral, the anal-sadistic and the genital.

Oral Stage of Sex Life

The activity of the oral stage consists of the various forms of sucking, biting and swallowing. This activity originally serves the food-seeking impulse, but the child soon derives a pleasure from sucking for its own sake, as witness the use of the comforter. Thumb-sucking may follow, and nail-biting is

a continuation of the early childish sucking habits. Kissing, too, is a form of sucking.

These early satisfactions are followed by the satisfaction obtained during the anal-sadistic stage by the exercise of the excretory functions. The child's interest in these functions, and the training in their control to which he is subjected, are regarded as playing a most important part in the development of character. Psychoanalysts have an elaborate classification of character qualities based on the habits of control, or lack of it, acquired in early years.

Anal-sadistic Stage

This stage is called the anal-sadistic stage, as the child not only obtains anal satisfaction, but satisfaction by behaving in a noisy and undisciplined manner, by teasing and sometimes downright cruelty. This satisfaction is described as sadistic, as a sadist obtains pleasure in inflicting suffering.

The third and last stage is the genital stage, when interest is shifted to, and satisfaction is derived from, the genital organs, which now acquire their life-long predominating importance.

Freud indicates another threefold division into stages of the sex life of the child, the stages being distinguished by the objects towards which the sexual activities are directed. The first is called the auto-erotic stage, the child loves, or seeks gratification, in his own body. The libido is directed towards his own person. This early tendency may be perverted and habits of self-abuse acquired. It may persist, too, as self-love, with consequent weakness of character. On the other hand, it may lead in after life to a perfectly healthy desire to be attractive to others.

The second Freud calls the narcissistic stage, after Narcissus, who fell in love with his reflection in a pool. In this stage, the child, as it were, falls in love with himself, the ego becomes the object of the libido. Both narcissism and auto-erotism mean self-love, but the latter is love of the body and the pleasure its stimulation gives. Narcissism is, on the other hand, love of the personality; it may be independent of love of body.

The critical third phase, the allo-erotic stage, is one in which the child seeks outside objects to love. In this search it is suggested that the child acquires a sexual attitude towards the parent of the opposite sex, and rivalry with the parent of the same sex. This is the famous Oedipus complex, regarded by Freud as the very core of the unconscious, and of such importance that the child's future character depends to a large extent upon the way in which he deals with it.

Allo-erotic Stage

Before dealing with the Oedipus complex in more detail, it may be pointed out that the allo-erotic stage includes the homosexual phase in which the child, just on the threshold of adolescence,

exclusively loves members of his or her own sex. This is normal in early puberty and the gang age when boys and, to a lesser extent, girls form groups which play an important part in the development of personality.

The Boy Scout and other movements for the welfare of children and adolescents are soundly based psychologically on this gang tendency. The tendency of this homosexual stage if properly directed leads to habits of loyal co-operation with members of one's own sex.

The next phase in the allo-erotic stage is the heterosexual when the interest is shifted to many persons of the opposite sex. This period normally is a preparation for the final choice of one particular member of the opposite sex.

Oedipus and Electra Complexes

The child, in the allo-erotic stage, inevitably seeks objects to love among those nearest, that is, those in the home; and a son thus acquires erotic attachment to his mother and hostility towards his father. This situation, the Oedipus complex, is, according to Freud, the normal family situation in the early years. The corresponding complex in the girl is the Electra complex, in which there is an erotic attachment for the father and antagonism to the mother.

The complex takes its name from the Oedipus of Greek legend who unwittingly slew his father and married his mother. The Electra complex takes its name from Electra who murdered her mother Clytaemnestra.

Freud thus regards these old Greek legends as representing an experience common to all children, which arises out of the early attachment of the child to the parent of the opposite sex.

The doctrine has aroused hostility and disgust, but psycho-analysts claim that the theory is supported by facts discovered in the analysis of their patients.

The complex develops out of the boy's early attachment to his mother, the joy of which is at first unalloyed, but is later interrupted by weaning, and possibly the arrival of another child. Punishment and correction will administer further shocks to the attachment.

During this period the boy has also become attached to his father who becomes his model with whom he identifies himself. Wishing to put himself in his father's place in relation to his mother, he is mortified to find that he is not permitted to do all that his father does. He comes to regard his father as a rival for his mother's affection, and as an obstacle to be removed. The father who is loved as a model, is also hated as a rival.

Mental Conflict

This double attitude causes conflict within the boy's mind, a conflict which is aggravated by the thwarting experienced when the love object, the mother, is denied him. The conflict comes to a head about the fourth or fifth year, when

interest is being aroused in the genital organs. Any sexual curiosity, and undue interest in and handling of these are met by the stern disapproval of both parents. Dire warnings may be uttered of the awful fate of the genital organs if such activities are continued.

Repressed Emotions

This threatening outlook makes the already existing state of conflict and thwarting still more unpleasant. The whole complex of emotions becomes intolerable and is repressed. The boy does this by completely adopting his father as his model. He obeys his father's injunctions "Thou shalt be like thy father," and "Thou shalt not slay thy father nor covet his wife."

These rules become the kernel of the ego-ideal or super-ego. From this obedience to the code laid down by his father, grows the boy's habit of deferring to the super-ego or conscience, which, as we have already stated, watches the ego and relentlessly directs it to stern standards of behaviour.

Freud's description of the formation and repression of the Oedipus complex, while very suggestive, is unnecessarily elaborate. As a matter of fact, the boy (and the girl) often adopts similar attitudes to both parents, and takes both as models. The double attitude (loving and hating) of the child to both parents is probably explained by nothing more startling than the fact that the child is treated both tenderly and harshly on occasion. But it should be remembered that psycho-analysts claim that the cure of a neurosis is aided if the patient accepts the Oedipus complex as true.

The distaste aroused by the doctrine is avoided if it is taken to mean that a child desires the undivided attention of his mother, and dislikes anyone who interferes therewith. This is probably all that is meant by the statement that the boy is in love with his mother and desires to kill his father. For the child to kill simply means, as it does in fairy stories, to get rid of.

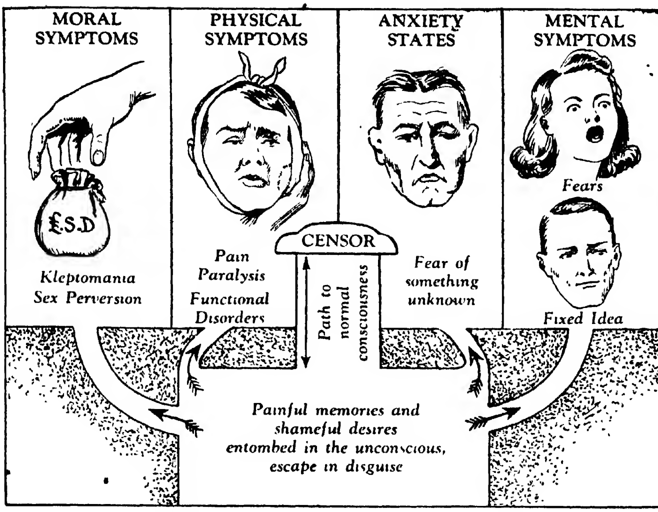
Causes of Neurosis

We have seen that a neurosis is a disorder of the nervous system for which no physical cause can be found. One man may have a brain injury resulting in paralysis; another man's paralysis may be due not to a physical injury, his brain being intact, but to a repressed fear.

The cause of an adult neurosis may be traced back to childhood. A child who fails to adapt himself properly to his home environment reaches adult life predisposed to breakdown in the face of life's problems.

Two factors in the production of the neurosis can thus generally be traced: the predisposing cause in childhood; and the present problem which is the immediate cause. The demands of the adult environment reveal that the neurotic has not completely 'grown up'.

A neurosis is the unhealthy manifestation of a conflict within the mind caused by a repressed



SYMPTOMS OF NEUROSES

A neurosis is a disorder of the nervous system caused by a repressed complex. The symptoms may take many forms, as explained in the text and illustrated above, and can occur without any physical cause whatever.

complex. Being denied expression, the complex bursts forth in the symptom of the neurosis which is a disguised satisfaction of the repressed impulses. The paralysis of the young woman referred to in Chapter Twelve (page 251), was a satisfaction of her unconscious desire that her period of nursing her father should come to an end.

Neuroses are of various types. In neurasthenia or nervous prostration, there is lack of physical and mental vigour; the patient becomes fatigued, abnormally lazy, and in fact seems to be in a state of perpetual tiredness. The self uses up so much energy in repressing the morbid complex that none is left for facing life and its problems. The complex is so deeply repressed that there is no expression in consciousness of the fear, sexual desire, assertiveness, or whatever the repressed impulse may be; the symptom is the continuous tiredness due to lack of energy.

The anxiety neurosis is distinguished from anxiety which is caused by a conscious conflict. In anxiety, we know what we are anxious about. In an anxiety neurosis, however, the fear is of something unknown.

In the neuroses called conversion hysterias, there are definite physical symptoms: a pain, lameness, sickness, even deafness or blindness. They are called conversion or substitution hysterias because a definite physical symptom is substituted for the unconscious conflict. A man may be always washing his hands. This mania for physical cleanliness may be a substitution for an unrecognized craving for a moral cleansing.

Irresistible Ideas and Phobias

The neurotic symptoms, instead of being physical, may appear as an irresistible idea, such as an idea that one has left some piece of work undone although it has been checked again and again; or an unreasoning fear, or phobia, as it is called, of, say, open or closed spaces, or of poison in one's food.

The symptom may be a disorder of conduct like kleptomania.

To summarize, every neurosis is due to a conflict, not between the self and the outside world but within the mind: it does not arise out of man's failure to adapt himself to his environment but out of his failure to adapt himself to himself. The neurosis is unconsciously desired. The illness enables him to avoid an issue he dare not face.

Inferiority Complex

The inferiority complex is a widespread disorder so important as to warrant special attention.

All of us are inferior in many ways, but we respond reasonably and healthily to our inferiority when we take effective steps to remedy it, or, if this is impossible, when we accept it. If a man is deficient in knowledge of an important subject, he can take steps to acquire such knowledge, or be content to remain in ignorance; but he should not refuse to admit his ignorance and pretend to a knowledge he does not possess.

The inferiority complex results from an unhealthy response to inferiority which in some cases is repressed. This refusal to face facts produces an unhealthy state of mind, characterized by a loss of self-confidence and perhaps by a feeling of helplessness strongly tinged with fear. The sufferer dislikes going into any company, or attempting any task, in which there is a risk of his being shown deficient in qualities which he likes to delude himself and others he possesses. In the end he often comes to despise himself.

Thwarted Self-realization

The complex is very distressing because it thwarts his desire for self-realization. He feels ineffective, useless, unimpressive and makes many misguided attempts to redress the balance and achieve superiority. These attempts are of three kinds: he may over-assert himself or assert himself in the wrong direction; he may retreat; or he may break down in a neurosis.

Over-assertion includes boasting, pompousness and generally "throwing the weight about." The blustering arrogance of the man suffering

from the inferiority complex does not deceive the discerning observer, any more than extravagant over-praising of goods by a salesman deceives a discerning buyer. Over-assertion sometimes takes the form of the adoption of an affected or "cultured" manner of speaking, mistakenly regarded as evidence of education and real culture.

Assertion in the wrong direction includes bad habits such as swearing, and breaches of etiquette and good taste, or even misconduct and crime. A man who is inferior, who cannot shine in company by showing good qualities, may endeavour to be impressive by the use of bad language or by flouting conventions. Boredom and dissatisfaction with life may lead to outbursts of drunkenness and various breaches of the peace.

Retreat from life and its demands, as a result of the inferiority complex, is shown by that form of self-effacement which is an expression, not of real humility, but of mock modesty and which is really an attempt to obtain praise for meekness. The individual uses his weakness to feed his vanity.

Retreat to Childhood

Another retreat is back to childhood. Adult life may be too difficult, so a craving for the security of childhood arises; a desire to have everything done by a loving parent. Thus a man, grown up in years, may slump into an attitude of over-dependence and demand to be mothered by his wife, whom he expects to wait on him hand and foot as if he were a child.

A childish phantasy may provide a line of retreat in which inferiority in capacity, and absence of achievement, are compensated for by making oneself the centre of a glowing phantasy in which one does exploits and in which one's merits are really recognized. Cinderella compensates for her inferiority as a kitchen-maid by dreaming of her Prince Charming.

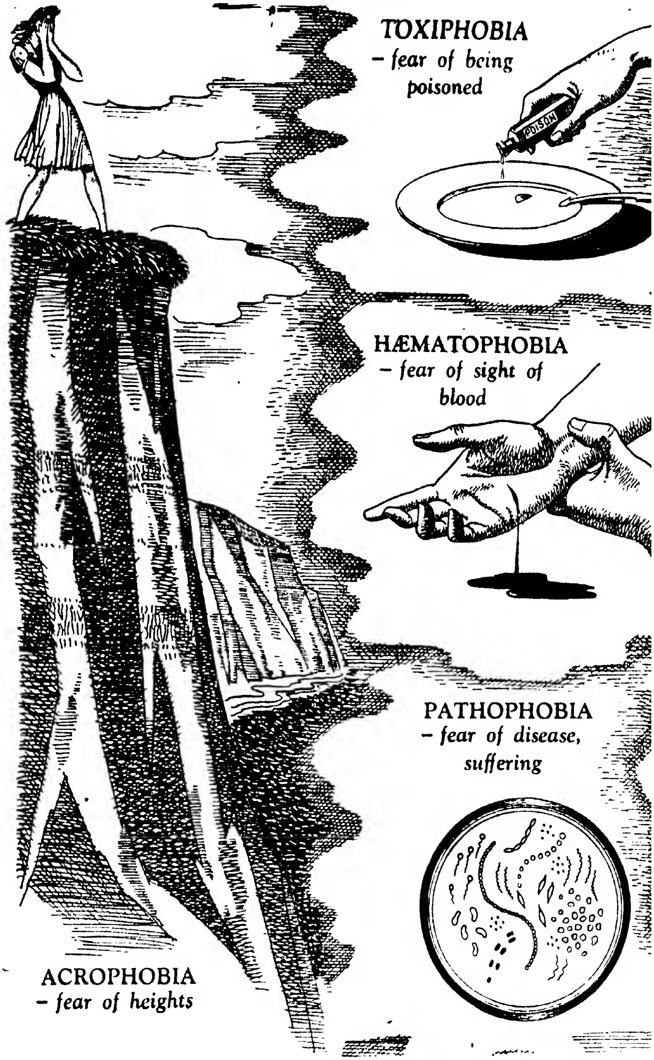
Nervous Breakdown

When the complex is completely repressed, nervous breakdown may result. An unwanted child, for example, may become obsessed with the idea that he is no use at all, that nothing he does is of any avail. This painful and humiliating complex is repressed but, in later years, causes a breakdown in face of difficulties which are felt to be quite insurmountable, because the attitude of childhood still persists.

The inferiority complex is generally caused in childhood. Thoughtless remarks, such as "I wish Mary had been a boy" or "Now that mother has a new baby she won't want you" may rob a child of that belief in self which is necessary for normal development.

If a child has a physical or mental defect and is, in consequence, treated as being of different clay from that of normal children, he may come to regard himself as hopelessly inferior.

The domination of a child by a parent may lead to the same result;



PHOBIAS—SYMPTOMS AND

A neurosis may be expressed in the form of a phobia, which is an irresistible fear of some specific state or action brought about by a conflict within the

EXPRESSIONS OF A NEUROSIS

mind, and for which there seems to be no reasonable justification. Some of the most common forms of phobia are shown in the above illustration.

the child, when grown up, is still tied to mother's apron strings, or under father's thumb, and feels lost and inferior without the parents.

An humiliating event, long since forgotten, may cause the complex.

Root Cause of Complex

The root trouble of the inferiority complex is that the individual despises himself, not that other people despise him. Despising oneself is frequently aggravated by the acceptance of foolish conventions, whereby a person's worth is measured by his social position, his poverty or wealth, trade or profession. Thus a person doing humble work, or living in a small house, may be looked down upon and may foolishly accept this valuation of himself.

The advice often given to the sufferer from the inferiority complex is—know yourself, be yourself and adjust yourself. Self-knowledge and self-adjustment are principles of general application in the cure of complexes. The help of a psychotherapist may be necessary to achieve complete self-knowledge but much can be done alone.

To get rid of a complex, one's attitude to the self and to others must be thoroughly revised. One must examine oneself without bias, examine real motives, and quietly think over one's past in an endeavour to find the cause of the present trouble. Impulses must be faced fairly and squarely. The advice of others may be sought. A real friend might be induced to give a considered criticism of one's personality and conduct.

In this self-examination the good in ourselves should not be overlooked, the possibilities and potencies. We should also realize our limitations, and if we are attempting what is genuinely impossible, it should be given up. If vainly attempting to excel in one direction leads to a feeling of inferiority and frustration, another task, well within one's powers, should be tried.

The important result of successfully dealing with a complex, whether by analysis, or in less serious cases, by self-knowledge without the aid of a therapist, is that the instinctive energy which has been misdirected in the complex is now released and can be used in the service of the will.

Harmony and self-adjustment are impossible unless one chooses values which are really worth seeking after. By seeking worthwhile ideals one realizes one's own worth and experiences a feeling of dignity instead of one of inferiority and frustration.

Worth-while Ideals

This then is the secret of self-adjustment, to direct our mental energy in a worth-while direction; to realize that by seeking after the eternal verities of truth, beauty and goodness, life is kept wholesome. Ideals based on these verities can harmonize all our impulses. The energy which is drawn from harmful complexes can be used to strengthen the will.

CHAPTER FOURTEEN

HABITS

Advantages of habits. Automatic action and automatic control. Acquisition of right habits. How sentiments become habits. The master sentiment or guiding principle. Necessity for acting on the ideal. Importance of self-respect in the formation of character. Good and bad character. How habits are formed. Breaking bad habits. Instinctive energy. Sublimation of impulses.

A HABIT is an acquired response to a situation, a response which is automatic and more or less invariable. Our many habits, whether bodily habits or habits of thought and conduct, are of great importance in our physical, mental and moral development. As the Duke of Wellington said, "Habit a second nature! Habit is ten times nature!"

Unconscious Direction

Habits are simpler, less fatiguing, and more accurate than unaccustomed efforts; they are remarkable labour-saving devices. As they develop, it becomes less and less necessary to attend to the actions concerned, until practice makes perfect and very complicated co-ordinated actions are performed without conscious direction.

A typist or cyclist is not efficient until the many movements required are carried through without thinking about them. The balance of a cyclist is preserved and his steering accurately controlled, the fingers of a typist are directed to the correct keys, not by conscious attention, but by the nervous system which seems to have grown to suit the required activity and has acquired independence of conscious control.

This is illustrated by the experience of William James when in Paris after an absence of ten years. He found himself outside the school he used to attend, forgot the present and walked on automatically until he came to himself on the stairs of a house many streets away in which he had lodged and to which he had habitually walked from school ten years before. The sight of the familiar street had again set in motion the habitual activity.

Forming Right Habits

It is this automatic quality of habit, and its independence of conscious control, which justify Wellington's remark that habit is "ten times nature," and the acquisition of the right habits is vital for the welfare of the individual and of the community. Habit is like an enormous fly-wheel which keeps the mechanism of society running smoothly. While it is unsound to regard morality as nothing but a matter of custom, it is of great advantage to make as many useful

and moral actions as possible habitual and automatic. This is an important aim in education.

The more we delegate the details of life to automatic control the more free are our higher mental powers to do work worthy of them. If rising from bed, dressing, washing, shaving, using knife and fork, evaluating seven nines, and a thousand other actions, minor yet important, were the subject of conscious control and decision, our mental energy would be exhausted long before we had time to do any real work.

The absent-minded professor is a subject for ridicule: for example, the professor who went to his room early one evening to change for dinner. On taking off his outer garments automatic control took charge; he placed his money on the dressing table, wound up his watch and finished up in bed. But, although we laugh at absent-minded professors, we should realize that unless they free their minds from the oversight of daily details they will never become learned in their subjects.

Habits and Instincts

Automatic action may also occur with moral habits, when, for instance, courtesy and unselfishness are shown readily without a great deal of deliberation. This is a mark of a developed character.

In Chapter Thirteen (page 258), reference was made to sentiments which are constellations of instinctive emotions around a central idea. Our sentiments for things, persons, or abstract ideas, are built up by the acquisition of habits of feeling and acting in a particular way with regard to these things, persons and ideas. In developing a sentiment of love for his mother, the links between the child's idea of mother and his emotions become stronger and more and more numerous until they form a lasting habit.

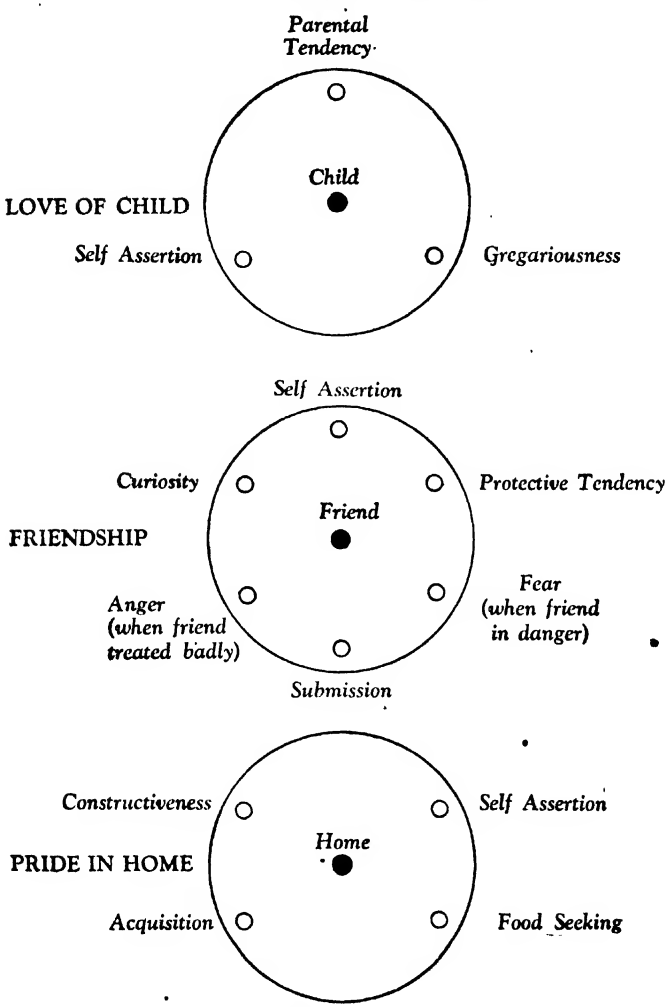
Ruling Passion

Other words for sentiment are interest and passion. Interest suggests rather an intellectual habit of response for matters more or less impersonal. Passion is a word used by older writers and emphasizes strong emotion rather than intellect. The importance attached to our chief sentiment, whatever it may be, is illustrated by Pope's lines:

"Search then, the ruling passion; there alone
The wild are constant, and the foolish known;
The fool consistent, and the false confest:
This clue once found unravels all the rest."

Sentiments are built up by the same process as that by which instinctive habits are formed. A child may acquire a habit of feeling afraid of a rabbit, or the habit of feeling hatred (a blend of fear and anger) for a dog which has bitten him; or later, the habit of feeling admiration for a worthy person.

A sentiment, however, is something more than a mere instinctive



STRUCTURE OF SENTIMENTS

Sentiments are constellations of instinctive emotions forming groups around a central idea. Above diagrams show groups around three central ideas.

habit, or conative habit as it is usually called. One man may have an habitual fear of dogs, because a dog bit him in childhood, but is otherwise unconcerned about them.

Personal Quality of Sentiment

Another man has a sentiment of love for dogs; everything about them arouses his warm interest and affection. If he hears dogs praised, his heart warms to the speaker; if they are disparaged and belittled his anger is aroused. Suffering dogs move him to pity and he labours for their welfare. They concern him in a personal manner.

Again, one man is habitually interested in an objective, detached, kind of way in ethics. He studies moral problems, but his conduct is not affected. He may adopt as his rule of conduct that wrong may be done so long as the eleventh commandment, "thou shalt not be found out," is unbroken.

Another man, on the other hand, has a real sentiment of love of goodness. His sentiment really influences his conduct. In a way he cannot explain, wrongdoing, although not directed against him personally, does affect him; something vital in him feels affronted.

This personal quality of the sentiment distinguishes it from a mere conative habit. If I have a real sentiment, my idea of the self is involved; I feel that any praise or blame of the object of the sentiment is praise or blame of me personally.

These habits we call sentiments are of vital importance in character development. If we make a list of our sentiments—that is, our likes and dislikes, our loves and hates, our interests and passions—for things, persons, groups and, most important, for ideals related to the eternal verities of truth, beauty and goodness, we shall give some indication of the kind of people we are. Such a list will not indicate the relative importance of our sentiments; whether, for example, our love of truth is stronger or weaker than our love of gain; this relativity is a question of character.

Definitions of Character

Character is an organization of sentiments and is manifested in action. Action is essential; character is thus on a higher level than intelligence. Intelligence plans but character performs. Intelligence is like the steering-wheel of a car; it determines the course, but cannot move the car one inch; character is like the engine. Steering-wheel and engine are both equally necessary.

Character is variously defined, but in all definitions organization is stressed. As character develops our sentiments become arranged in an order of relative importance in a hierarchy ruled by a master sentiment.

According to McDougall, the sentiment most fitted to be the master sentiment is self-regard. This sentiment, in which the idea a man has of himself habitually arouses in him various emotions, has several forms: self-esteem, self-respect, or less worthy forms,

such as ambition, pride, vanity and selfishness.

The imperfect forms of the sentiment may lead to vigour of character and consistent conduct. But if the sentiment in its highest form, that is self-respect, is inspired by a noble ideal, it will arbitrate in all questions of right and wrong, will dominate conduct and organize a strong moral character.

Guiding Principle

The quality of character depends on the nature of this ideal or guiding principle. High character presupposes habitual action on a high ideal; an ignoble standard means ignoble character. The guiding principle habitually changes the direction of our instinctive impulses; and character may, therefore, be defined as an enduring disposition to control instinctive impulses in accordance with a guiding principle or ideal.

A miser possesses character, but not good character. His guiding principle is love of gain. All his impulses are so directed as to serve his master impulse, the acquisitive. Thus Scrooge, the miser in Dickens's *Christmas Carol*, was told: "I have seen your nobler aspirations fall off one by one, until the master-passion, Gain, engrosses you."

A different guiding principle, say love of humanity, makes a different man. His instinctive impulses are the same as all men's, but they are directed to harmonize with a noble ideal. Scrooge changed so remarkably because his guiding principle had changed; love of gain gave way to love of his fellows.

In good character the guiding principle applies to all the instincts. A man may be noble in many ways, but if one instinct is uncontrolled by his guiding principle the whole character is marred. Virtues are not set against vices and a balance struck between the two.

By habitual action on the guiding principle, character is developed; the process is normally gradual, although under the influence of a powerful ideal the change can be rapid. Important as the early years are in forming character, it can change and develop throughout life.

It should be stressed that the mere possession of noble sentiments does not constitute good character; these sentiments must be organized into a stable, harmonious system.

If this organization is lacking, the individual is like a business without a head. The very word organization implies a ruler; and to achieve good character the sentiments must be welded into a unity under the rule of the master sentiment, self-respect. Self-respect must in turn be inspired by an ideal of character; and there must be habitual action in accordance with the ideal.

How Habits are Formed

Habits are formed in three ways: by conditioning a response; by the law of exercise; and by insight. What are called nervous habits, for example stammering and twitching, are generally the symptom of a

neurosis and are outside the scope of our present discussion.

The process of conditioning is as follows: If a stimulus A always evokes a certain response, and if a new stimulus B is repeatedly presented at the same time as A, then after many repetitions it will be found that B alone will elicit the original response. A new bond or habit linking B and the response has been formed. Thus, by conditioning, a child may acquire a habit of fear of furry animals; or of the dark.

Symbols frequently become conditioned stimuli arousing the response appropriate to the cause for which the symbol stands. The cross to the Christian, the flag to the patriot, are symbols which evoke habitual responses as the result of conditioning. The causes for which these symbols stand arouse emotion in their adherents; later the symbol becomes the conditioned stimulus which arouses the emotion.

The law of exercise simply means that practice makes perfect; that constant repetition of an act makes that act easier to perform. The bonds between a stimulus and a response are strengthened by use and weakened by disuse.

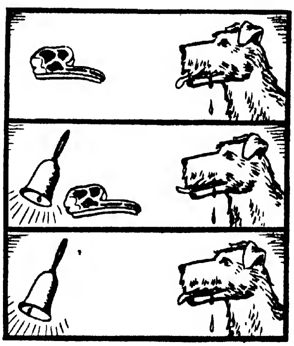
The part played by insight in habit formation tends to be overlooked by those who seek to explain habit formation in purely mechanical terms. Many vain attempts by trial and error may be made to solve a problem or to meet a situation; but suddenly the solution flashes to mind and the correct response will be made thereafter. A habit has been formed, as it were, in a flash.

Kohler, in his observations of the behaviour of chimpanzees, set them the problem of getting food which

The saliva is the natural unconditioned response of the dog to meat

The bell and meat (conditioned stimulus) are then presented together

After a number of repetitions the bell alone now habitually evokes the saliva



HABIT FORMATION I—CONDITIONED REFLEX

Many habits are formed by conditioning a reflex. That is to say, if a stimulus B is presented at the same time as a stimulus A which invariably evokes a certain response, after many repetitions B alone will elicit the response.

The two activities of reading and smoking occur together

Then a number of repetitions accompanied by a feeling of satisfaction

Reading and smoking now habitually occur together

HABIT FORMATION II—LAW OF EXERCISE

In forming a habit practice makes perfect, and the law of exercise simply means that repetition of an act makes it easier to perform. Bonds between stimulus and response are strengthened by use and weakened by disuse.

was out of reach. Again and again he observed that the animals after a period of looking round would suddenly hit on the solution. One animal was faced with the problem of reaching a banana outside his cage although no stick long enough was available. After a time, the animal solved the problem by insight. He joined together two short sticks to make one long enough. This insight into the solution of the problem was sufficient to establish the habit of joining the sticks thereafter. (See also similar problem illustrated on page 277.)

To see clearly the implications and solution of a moral problem, to see one's duty, is often sufficient to establish a habit.

In acquiring habits, the tendency of converting means into ends should be avoided. We may acquire a habit which serves a good end and gradually forget the end; and continue the habit merely for the sake of the means.

Many house-proud women, to whom tidiness and cleanliness have become almost obsessions, and whose houses are like museums, have quite forgotten the end toward which their habits of tidiness were originally directed, namely, the comfort and happiness of the occupants.

Similarly, the acquisition of money—originally as a means to an end—may degenerate into an end in itself. We should constantly recall the end toward which our habits are directed, thus preventing a distorted perspective.

The acquisition of a good habit often means that a bad habit dies of disuse. Thus, if a man determines to be cheerful his bad habit of grumpiness must cease.

We are helped in the formation of a new habit if we have a clear

view of our objective and pursue it with concentration and determination and with confidence that we shall succeed in our quest. It helps, too, if we choose as far as possible the company and surroundings which will encourage the formation of a good habit or the dropping of a bad habit. An open avowal, perhaps a definite pledge, made in the presence of those who know us, favours success, as our reputation and self-respect are at stake.

Breaking Bad Habits

Those desiring to break an addiction to drugs or alcohol, or any other bad habit of greater or lesser seriousness, often aver that it is impossible to give it up all at once. This should never be conceded unless it is found to be quite impossible to make a clean break. In fact it is found that if a desire is never fed it dies much more quickly than is commonly supposed, especially if we seek instead some worthy aim.

When a good habit is being cultivated, especially if by so doing a bad habit is being killed, no exceptions should be allowed until the good habit is firmly founded. Ground once lost is very difficult to regain.

Many bad habits involve the misdirected expression of an instinct and in breaking such habits it is necessary to provide a satisfactory outlet for the instinctive impulse which is released.

Instincts crave for expression, and repression is dangerous; but let it be repeated that repression is not self-control. Repression is a morbid unconscious process resulting from an individual's refusal to admit that an impulse exists; but in self-control an impulse is recognized and redirected to worthy purposes. One of our greatest problems in habit formation, and its culmination, character formation, is to find worthy and healthy means of expression for the instincts.

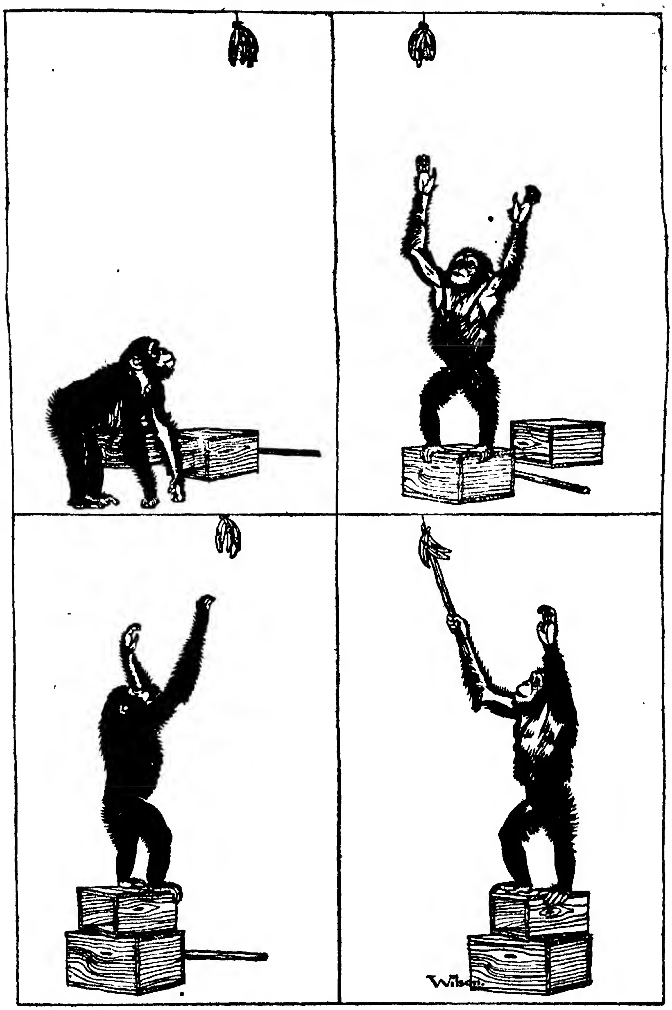
An instinct can be expressed in three ways: it can be expressed naturally; it can be perverted; or it can be sublimated.

As members of a civilized society, we realize that it is quite impossible for our instinctive impulses always to be expressed naturally on the prompting of mere desire. In fact, civilized man is distinguished from the savage by the very fact that he does not express his impulses in a crude, unrestrained manner.

Energy Redirected

As man has developed, the expenditure of instinctive energy required in satisfying his bodily needs has become less and less, but the amount of energy available has not decreased, and some of the surplus energy has been redirected into activities such as art and learning which are the pride of civilized life. But civilized man has by no means completely controlled his instincts and is much troubled by the problem of their redirection.

The advantage of redirecting impulses is well illustrated by the analogy of a swift mountain



HABIT FORMATION III—BY INSIGHT

Formation of habit by insight, after vain attempts by trial and error, is illustrated by the behaviour of chimpanzees, as observed by Kohler.

stream. If the stream rushes uncontrolled down the mountain side it may do great damage. A village in the valley may be flooded and lives may be lost.

If, however, this stream is directed through channels and pipes, and ultimately through machines, electric current may be generated, and the stream, instead of causing death and destruction to the villagers, provides them with light and power. The energy is the same in both cases; only its direction has been changed.

Similarly, steam when bottled up causes explosions, but it drives machinery when directed through pipes and pistons.

These analogies remind us that instinctive energy, if repressed, or if crudely expressed without control, causes disaster to personality; but if worthily directed, enriches and strengthens personality.

Sublimation of Impulses

We have seen in an earlier chapter (page 210) that this redirection of impulses is called sublimation, or lifting up. In sublimation, the instinct is directed toward a purpose which is both satisfying to the individual and of value to the community. The phrase, "satisfying to the individual," should be understood to cover not only the pleasure experienced in satisfying an instinct, but the satisfaction experienced by acting in accordance with one's higher self.

For an instinct to be sublimated it must be recognized as part of the self. If, for example, the sex impulse is regarded with disgust or suspicion, regarded as a kind of poor relation, or is repressed, it cannot be sublimated; and no amount of creative work (often a very good sublimation of the sex tendency) will bring satisfaction, and it will certainly not be of any value to the community.

Effect of Sublimation

Sublimation, although not as fully satisfying as the natural use of the instinct, keeps the personality sweet and free from neurosis. It may, too, be of great value to the race. Mankind owes a heavy debt to some who have completely sublimated their instincts in unselfish service to others.

In discussing sublimation of the sex impulse, it should be realized that the instinct is really a blend of many impulses. It certainly includes self-display and the desire for admiration; self-assertion, particularly in the male, and submissiveness, particularly in the female. Whether the rapidly lessening economic dependence of woman on man is modifying female submissiveness is an interesting question.

Then the instinct includes the creative impulse, primarily for the creation of a child, but demanding satisfaction even if its primary purpose is unfulfilled. Closely allied to the sex instinct is the maternal instinct for the care of offspring.

The sublimation of the instinct, therefore, requires the redirection of all these subsidiary impulses.

As they vary in strength between individuals, each individual must decide which form of sublimation suits him best.

Self-display Sublimated

The self-display impulse and the craving for admiration can be sublimated in the activity say, of a preacher, actor or poet, for the good of the community. Here a paradox must be noted. If the pleasure arising from satisfaction of the self-display or any other impulse is consciously sought after, sublimation is not effected; the conscious attention must be directed to the work for the good of the community—the satisfaction to the self follows as a by-product. In other words, the self must be wrapped up in the good work.

The creative impulse is sublimated in all forms of creative work: art, writing, handicrafts or organization. It is interesting to note that an author or artist will sometimes call his work his child.

Some other sublimations are: that of self-assertion in leadership, which is really for the good of the community, not in mere love of power and "bossiness" (a real leader is a servant of the community); of submission, when a man, in spite of pain and perhaps ignominy, persists in a course he believes to be right. He does not ape the martyr, does not seek martyrdom, but accepts it without flinching if necessary in the service of his ideal. Often the service to the community rendered by such choice spirits is not recognized by their own generation but by those who follow after.

Curiosity is sublimated in scientific research for the good of the community. Many lives have been saved by drugs discovered by patient sublimated curiosity after hundreds of experiments.

The maternal instinct is sublimated when a child is adopted; or in nursing, or teaching and training the young. It is not sublimated when all the maternal care is lavished on a dog. Faithful animals as dogs are, to lavish all one's care upon them, to the exclusion of fellow human beings, is not for the good of the rest of the community and, therefore, is not a sublimation.

Forming a Sentiment

In practice, we rarely achieve sublimation by saying "I want to sublimate my instincts; what noble cause can I take up?" But we achieve it indirectly after acquiring an interest in and affection for the worthy cause.

In other words, in true sublimation the redirection of the instinctive emotions is effected by the formation of a sentiment. An uplifting love or interest draws off the instincts from undesirable ends to new and higher ends.

A man's life may be a psychological chaos until a sentiment for an ideal redirects and unifies his impulses. By losing ourselves in our work, in loyalty to others, in devotion to a purpose larger than ourselves, we in truth find ourselves.

CHAPTER FIFTEEN

SELF-CONTROL AND CONSCIENCE

Difference between self-control and repression. Direction of instinctive energy. Emotions and temperament. How conduct is determined. Importance of an ideal. Effect of ideals on personality. How conscience guides us. Nature of right and wrong. The development of a strong moral character.

SELF-CONTROL is often confused, sometimes deliberately, with repression; and as nervous disorders can be cured by the release of repression, this confusion leads to the mistaken view that such disorders can be cured by relaxing self-control; that harmony within the self can be achieved by giving unrestrained expression to impulses, even if conscience is violated.

Repression, as we have shown, is unhealthy and causes many disorders; but self-control is both healthy and necessary for true happiness and development of character.

The two processes differ fundamentally. Repression is unconscious and has its origin in a refusal to face an impulse, a refusal to accept one's instincts as part of oneself; they are treated as poor relations unfitted for polite society. In self-control, however, we face and recognize our impulses, accept them as part of the self and take them into partnership in the development of the personality.

If a so-called mental healer advocates, say, sexual licence as a cure for neurosis he brands himself as inefficient; the patient by this process simply substitutes government by an instinct for government by his moral sense, which is now denied and suppressed.

Self-control is necessary, therefore, because we have this moral sense; because our needs are not completely met by the satisfaction of our instinctive tendencies. It is natural to seek satisfaction of these tendencies, to seek to satisfy our desires for food, sex and society; but it is also natural to seek after higher values.

We most of us admit this, and even those who do not, reveal from time to time their longings for these higher satisfactions of truth, beauty and goodness; in fact, whenever we describe an action as higher or lower than another, we pay tribute to these values.

Our seeking after values is not only a matter of ethics, it is a matter of such psychological importance as to control personality. To change human nature is very simple, yet difficult. All that is necessary is to change our scale of values; but this cannot be achieved unless instinctive impulses are controlled.

In achieving this control, we must take the old advice "know

thyself" and realize that our impulses can be directed to serve our highest purposes.

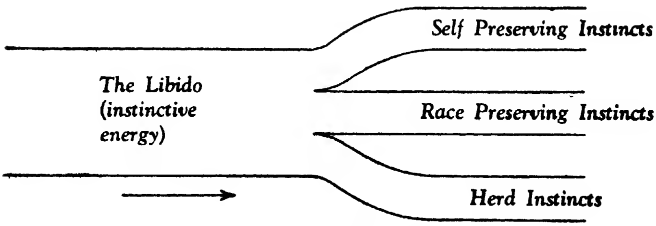
If a man refuses to admit his fear, he will become so obsessed with it as to become a nervous wreck; but if he admits it he can control it. Of two men about to face great danger, one boasted that he felt no fear, the other replied, "If you were half as afraid as I am you would have run away long ago."

The first man was not facing his fear, was trying to delude himself that it did not exist; the second knew his fear and controlled it. When the real danger came, the boaster panicked and fled, but the man who admitted his fear bravely stood his ground.

In knowing ourselves we distinguish between a desire, and an intention to express it in conduct. We have instinctive desires which arise whether we will them or not —sex desires, desires for mastery, and so on. We should recognize and accept them as normal; but whether we allow them expression, even in imagination, is quite another matter depending entirely upon character.

To have an impulse to act wrongfully, an impulse to express an instinct in a manner out of harmony with the better self is not wrong in itself. Such an impulse should be recognized and not driven underground to poison the personality. But although recognized, an illicit desire should not, as it were, be fondled and satisfied in imagination; this habit is most dangerous and may carry us into overt action when we least intend and expect it.

The notion of energy, a word derived from a Greek word for work, is very helpful in solving this problem of the control of our impulses. Thus the various forms of physical energy, heat, light, electricity, chemical reaction, are used in countless ways; in the devastation of war and the reconstruction and healing of peace. In controlling the physical environment man directs physical energy to his many



INSTINCTIVE ENERGY AND ITS OUTLETS

Our instincts are expressions of one elemental energy, called the libido, and character is determined by the way in which this energy is directed through the channels of self-preserving, race-preserving and herd instincts.

purposes; similarly, instinctive energy is directed to various ends with consequent making or marring of personality.

Checking an Impulse

Instinctive impulses can be dealt with in four ways. In two of these the impulses are recognized and accepted as perfectly natural; but in the other two they are regarded as abhorrent.

In the first, although an impulse is faced and accepted as part of the self, it is checked and not allowed to issue in conduct. A man may thus check his desire to use his superior strength and "jump" a bus queue, or his sexual desire for one he loves, or his desire to make money by the improper use of information coming to him on trust.

We all need from time to time to check our impulses; but the need for such absolute restraint becomes less and less as real self-control increases. Rigid restraint is a temporary policy while self-control is being learned.

In self-control, the second process in which the impulses are recognized and accepted, they are directed to higher purposes. In the three examples just given, the man restrained his assertive, sex and acquisitive impulses. He could express the first impulse in self-control if, for example, he disciplined himself to arrive earlier and so obtain the right to a favourable position in the queue; or if he endeavoured to benefit all passengers by undertaking a campaign to improve the bus service. To achieve this aim would need a good deal of intelligently controlled and directed assertiveness.

His sex impulse can be controlled by the various means of sublimation already described. It is noteworthy that a man's sexual desire for the girl he loves, by control and sublimation, gives energy and vitality to all his activities for her sake in preparation for marriage and a home. He becomes more alert and efficient in his work and his play.

The third of the impulses referred to, the acquisitive, is controlled if it is always kept subsidiary to some worthy end and money and goods are not sought after as ends in themselves. In general, in self-control, our impulses are our servants and not our masters.

Suppression and Repression

The other two ways of dealing with instinctive impulses, in which they are regarded as abhorrent, are suppression and repression respectively. In both there is a thrusting or pressing away from consciousness of the impulse, an attempt to delude oneself that an impulse or desire does not exist. In suppression there is a conscious inhibition, the complex is recognized; but in repression the process has been relegated to the unconscious, in other words, a man has succeeded in deluding himself that a complex does not exist.

Before further considering the control of instinctive impulses, the effect of control on feeling and

temperament should be mentioned.

Feeling cannot be directly controlled. If I desire to feel happy I cannot will a feeling of happiness; but feeling can be indirectly influenced by dealing with the object arousing the feeling, and in some cases by controlling the bodily expression of a feeling, as the lady referred to in Chapter Nine (page 206), whose husband was gravely ill, learned to her surprise.

Value of Reflection

The object causing an emotion can be dealt with by calm reflection; if we reflect, for example, that the man who annoys us so intensely is probably an ordinary well-meaning individual like ourselves, our stress of feeling will be lightened. It is sometimes a corrective to emotional disturbance to reflect that it will make no difference in a hundred years. If such looking ahead is not allowed to encourage neglect of present duties, the practice restores a sense of proportion when one is getting overwhelmed by feeling.

Many people are much concerned by their temperaments, which seem so fixed and unalterable. A theatrical manager obtained an insurance policy for £5,000 to cover loss through the temperamental tantrums of a prima donna! Temperament, a lasting emotional mood, is the effect on mental life of chemical changes in the body and shows itself in the qualities of the introvert and extrovert described in Chapter Twelve (page 256) and in such qualities as hopefulness, rashness, optimism, pessimism, reflectiveness, stubbornness, irritability, placidity, sensitiveness.

These are tendencies to feel our emotions in ourselves and to show our emotions to others in the ways mentioned. Thus, a choleric man feels and shows his feelings urgently and explosively; whereas a phlegmatic person feels and shows his feelings coolly and calmly. Temperament has a physical basis and we must accept it.

But although, for example, the extrovert cannot change his tendency to precipitate action before thinking, or the introvert his tendency to brood and reflect too long before acting, or the sanguine person his tendency to over-optimism, or the melancholic person his tendency to look always on the dark side, yet they can all remember that these qualities are tendencies only and need not dominate conduct.

Overcoming Temperament

If I know that I am temperamentally inclined to under-estimate difficulties, to act without thinking, it is my duty to allow for this in action—to make sure that I have carefully thought out a project in all its aspects before acting; or if I am prone to reflect too long before action, I must see that when I have thought out a plan I act on it at once. We are not mere creatures of our temperaments; they can be controlled.

One instinct may be controlled by another, a stronger impulse. A

hungry man has an impulse to enjoy a good meal in the warmth of his home, and another impulse, much weaker, to go out into the storm and darkness to conduct his old uncle home.

Deciding Factor in Conduct

If these two impulses are the only two concerned the stronger will win and the man stays in. But if the second impulse is to take an attractive young woman home it may be stronger than the first and he leaves his attractive meal. Or the man may have expectations under his uncle's will and, therefore, he sacrifices his comfort to the old man's welfare.

In these examples we have a stronger impulse controlling a weaker; but conduct is not always decided on this low level in which the deciding factor is the degree of pleasure—or discomfort—we experience. The deciding factor may be fear of punishment.

Our conduct is not yet fully explained. We may be influenced not by desire for instinctive pleasure or avoidance of pain, nor by fear of punishment, but by anticipation of praise or blame. There may be no question of physical pleasure or suffering, or material gain or loss, but we still act, or refrain from action, because we know that we shall be praised or blamed. Thus, the man we are considering may be influenced to action by anticipation of blame if he allows the old man to go home alone.

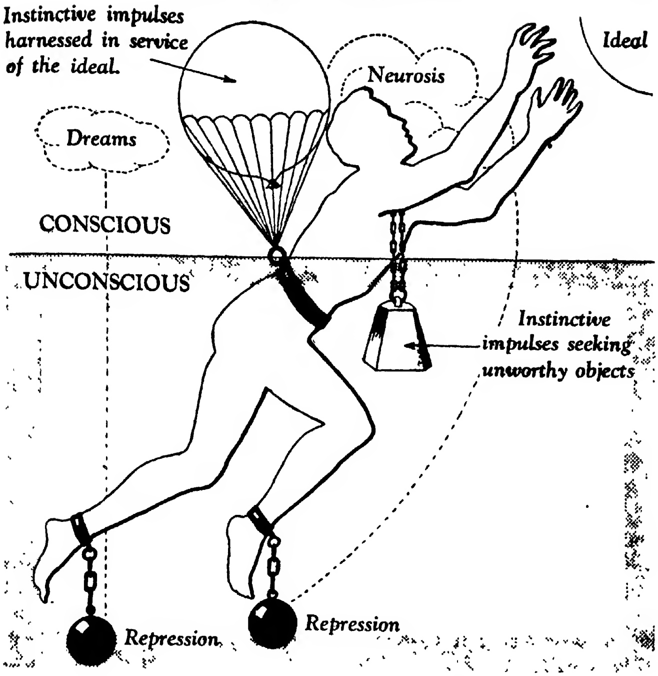
Most important of all, an ideal may decide the issue; the instincts are controlled because control is right. If the man in his comfortable room, about to enjoy his well-earned meal, is a doctor and is called to a patient gravely ill, he braves the elements although the mere instinctive impulse so to do is weak. This weak impulse is reinforced not only by the anticipation of blame which he would suffer if he refuses the call, but by the high ideal of service of the medical profession.

Suppose, however, a man learns that his worst enemy is helpless, and that no one will ever know whether or not he goes to his assistance, then his action will be decided by the nature of his ideal of character, perhaps whether it includes as a guiding principle—love your enemies. Our self-control is very seriously tested when we are convinced that no one will ever know what course we take.

Power of an Ideal

We thus find that an instinctive impulse, however weak, when reinforced by an ideal, can overcome a much stronger impulse. What is the special quality of an ideal which makes it so potent in influencing conduct and character and enables it to organize all the instincts into a harmonious whole?

This power depends upon the fact that an ideal can stimulate the will, that is, can stimulate the whole self to activity; an ideal is a driving force, a spur to action; it is also a lodestar leading us on. Without a



EFFECT OF IDEAL ON CHARACTER

An ideal brings harmony and stimulates the whole self to activity. Instinctive impulses, instead of being like weights on the self, or being repressed, can be directed to the service of the ideal, which is like a lodestar leading us on.

unifying ideal the personality will not be fully developed.

The relative merits of the various ideals inspiring mankind are, strictly speaking, not a question for psychology. Throughout the ages, the great religious teachers, the moralists, the philosophers, the artists, have pointed mankind to God, to right conduct, to truth and to beauty, but the ideal commanding general acceptance has not yet been formulated. Psychology is, however, deeply interested in the effect of ideals on personality; in very truth an ideal can revolutionize a personality by drawing to itself all the emotions, by substituting unity for conflict.

The psychologist is also interested to observe that the ideal, to be really effective, must be related to the eternal verities of goodness, beauty and truth. We are not fully

explained in terms of physical, instinctive and intellectual processes; all these processes are natural to us; it is also natural to seek after the eternal verities, to lose ourselves in something which is greater than ourselves.

Man's Religious Sense

Animals display intelligence, and there is even evidence in certain creatures of a sense of beauty and a rudimentary moral sense; but man possesses, as a quality peculiarly his, the sense of the sacred. He can respond with his whole being to a quality, or spirit in the universe, which evokes his reverence.

To the extent we perceive the nature of the universe, interpret it, and base our conduct on our beliefs, we achieve integration. It will be remembered that the task of the physician in curing a neurosis is to substitute integration for conflict within the self, and that Jung testifies that his problem is that of helping his patients to find a religious outlook on life. The religious attitude and integration of personality are thus obverse and reverse of the same condition.

Varying answers are given to the question "What is your ideal?" Some re or the Christian, others the Sto till others the humanitarian. ecause an says he is a Socialist praised a Communist. Love of we are con r worship of the state clai to action giance of others. Many if he allo d difficulty in naming ne alon al, but difficulty in naming mporta eal is no proof that we have none. The effect of an ideal is shown in conduct.

In testing the value of any given ideal in building personality, we observe its power, or lack of it, to attract all the instinctive emotions with resulting harmony within the self, and to provide a purpose in life which stimulates the will to activity and gives a person a sense of fulfilment, and the conviction that his life is worth while.

Unfortunately, we are often misled by false ideals. We feel that a certain aim is worth pursuit, that it will fully satisfy all our longings and call forth all our powers, but we are deceived. Thus, mere ambition, self-indulgence, money-making, the lust for power, are adopted as the guiding purpose in life by those who fail to realize that for an ideal to be real it must satisfy all our nature, must call forth qualities of mind, heart and will, and satisfy our innate longing for ethical values.

Acting on an Ideal

It will be remembered that character is the enduring disposition or habit to act on a guiding principle. The mere possession of a principle is not enough; there must be action upon it. An ideal is something more than a signpost pointing the way; it moves us to action. Therefore, if we claim to possess a high ideal we must show it in action.

We have seen that a sentiment is something more than a mere conative habit; it involves the idea of

the self. If a man has a sentiment of love of justice, that is love of justice for its own sake, not love of justice only for people he likes, he will feel affronted personally when injustice is done—even to strangers. There have been cases of miscarriages of justice which have been remedied after years of effort and expense by persons who, although perfect strangers to the sufferers, have been deeply affronted by their suffering.

Real Sentiment

Some people show courtesy, punctuality, tidiness, in their business dealings—it pays them so to do—but in other relationships these virtues are conspicuously lacking; indeed, the virtuous conduct at business seems to induce a determination to be free from such trammels elsewhere.

Such people have not a real sentiment of love of courtesy, punctuality or tidiness; if they had, these qualities would be shown in all their doings. This principle, thus illustrated in minor virtues, also applies in the great virtues. Consistent action on an ideal is, therefore, impossible without a genuine love for it.

The laws of habit operate in this sphere as in others. By habitually acting on an ideal the stronger its influence becomes; to ignore an opportunity so to act weakens it. This is a subtle danger, as it is easy to acquire a habit of making feeling a substitute for action.

We may be inspired by the presentiment of a noble ideal in a sermon, lecture, play or book and be filled by a desire to do noble deeds. Unless such desire is expressed in action, even by going out of our way to do a good turn, we are probably no better, and possibly worse, than we were before the inspiring experience. Feeling has not led to action, but to a spectator attitude to life and its problems, in which mere feelings are enjoyed for their own sake. A man may be stirred to the depths by the simulated wrongs of actors on the stage, but takes no steps to help those close at hand in real life.

The problem of acting up to our ideal is, therefore, solved by strengthening not only our sentiment for it, but the habit of acting on it and trying to allow no exceptions. The more completely we lose ourselves in an ideal, the more completely our mental energy is directed from less desirable objects.

Conscience as Guide

Self-criticism is an essential mark of character, and in judging whether or not our conduct is in harmony with an ideal we are guided by conscience. The nature of conscience, of the good, of the moral criterion, are matters for the student of ethics. We in this part are concerned with psychology, and will confine ourselves to one or two facts of experience involved in moral conduct.

The first is that conscience, which is a person's attitude to the ethical implications of his own thoughts and actions, involves knowing,

feeling and striving. We not only know what we ought or ought not to do, but we experience a blend of emotions and impulses. We thus know that an action is wrong, we feel shame or remorse, and are impelled to act. We talk of conscience accusing, rebuking, remonstrating, approving, impelling.

Right and Wrong

The next fact of psychology to be noted is, that, argue as we will as to the precise nature of the good, we have a conviction which cannot be explained away that there is an objective right, existing independently of our individual judgments of right and wrong, that right and wrong are not merely matters of feeling; that some actions are right, others are wrong, whether or not a particular person thinks they are.

This has been denied and judgments of right and wrong reduced to the level of mere feeling. As one and the same action may be regarded by some persons as right and by others as wrong, it has been argued that right and wrong are merely matters of feeling, and that such feelings have no more validity than those involved in one person's feeling that vinegar is nice and another's that it is nasty.

But it is always found that the denial of this belief in the objectivity of the good is couched in terms which assume its existence; such denials cannot avoid using the terms higher and lower in describing actions. All men and women are so made that whatever their characters, and theoretical beliefs, they must admit, when driven into a corner, that one act is on a higher level than another.

We thus sum up this question of character, conscience and conduct, from the psychological viewpoint.

Strong moral character is an organization ruled by the sentiment of self-regard, in its highest form of self-respect. This master sentiment is able to rule as it is inspired to action by an ideal of character which embodies various moral sentiments; for example, love of truth, of beauty, of goodness, love of generosity, of justice, hatred of baseness, meanness, cruelty.

These sentiments give rise to impulses and desires which overcome conflicting and unworthy impulses owing to the backing of self-respect, which is very sensitive and desires strongly to acquire the qualities dependent upon these sentiments. Conscience informs the self whether or not an act is in harmony with the ideal of character and expresses approval or disapproval accordingly.

Value of Self-respect

In developing character in ourselves, or in training others to do so, self-respect and a belief in the worthwhileness of the self must be encouraged. An ideal character, possessing the highest qualities we know, should be envisaged, and its qualities contemplated and valued. Not only should they be valued but, once accepted, on every available occasion they should lead to action.

PART 3—MORAL MAN

CHAPTER SIXTEEN

MAN IN SOCIETY

The moral element in man's make-up. The moral struggle. Nature of right and wrong. How our actions are determined. Idea of duty. Free will. Influence of heredity and environment. Mechanistic view of human conduct. The search for the good. Pleasure and happiness. Consequences of an action. Functions and types of government. Attainment of freedom.

THIS section brings us to a consideration of ourselves as moral creatures. It is concerned with the analysis of human action in so far as this is influenced by ideals and ideas of right and duty; and with the nature of what we call, for want of a better name, moral judgments: that is, judgments about things and people in which are the ideas of value, praise and blame, approval and censure.

You will see from this that it is very closely related with previous sections, in which were explained, first, the working of the body and, secondly, the working of the mind. Action is determined partly by bodily and partly by mental factors. In this chapter we shall analyse several kinds of action and, in particular, moral conduct.

By virtue of the moral element in his make-up man is most sharply distinguished from the animal kingdom; for many of the attributes of mankind are found also among the animals, but this capacity for judging actions right or wrong, and acting in accordance with these judgments, is peculiar to man among all living creatures.

So, at first glance, it appears that this is a very vital phase of man's nature which we are going to examine—in some ways it is perhaps the most important—because in the history of the world, or rather in the history of mankind, any breakdown in the standard of personal morals has always been followed by a collapse of the very fabric of civilization.

Morals in twentieth-century ears sound perhaps a little dusty and have a flavour faintly reminiscent of Victorian England. If they do, it augurs ill for the survival of modern

progress. It was so in the later days of the Roman Empire, when preconceived standards were discredited and the former hardworking Roman citizen turned from his labours to a life of luxury, idleness and vice, unperturbed by the clear call of duty. That moral landslide was followed very soon by the fall of the Roman Empire and its disastrous consequences.

Essence of Morality

What is moral conduct? If that were an easy question to answer perhaps it would seldom be abandoned in favour of the easy self-indulgence which lies at the root of moral decadence. It is this difficulty in defining it which breeds doubt, and doubt brings in its train carelessness and a gradual abandonment of the moral struggle.

In those two words—moral struggle—you have the very essence of morality. They imply that moral conduct is not the easiest course, that it involves a definite overcoming of motives inspired by selfishness, or greed, or the lust for power, or some other of the instincts which, if left to lead us on our course unchecked, often prove unsocial in tendency.

Let us take it for granted then that some actions are right, others wrong, and let us try to define the subject matter of this chapter more exactly so that we can discuss it in the light of what thinkers of every age have thought about it.

What then do we mean when we say an action is right or good or moral? What exactly do we mean by duty? How is it that we have come to attach definite meanings to these terms? To what authority can we turn to discover what course of action we ought to take in order to do what is our duty in any given circumstances? If you know the answers to these questions you will learn very little from the pages which follow. But if you do really know the answers you are wiser than any of the great philosophers. All we can hope to do is to examine the facts impartially in the light of reason, casting aside, so far as we are able, any thoughts inspired by emotion, and so try to form for ourselves a considered opinion on these topics.

Opinion is quite different from knowledge. What we know we must know either from experience or, as some suggest, by immediate apprehension of the truth.

Knowing Right from Wrong

The nature of right and wrong, on the other hand, cannot be deduced easily from experience, nor is it capable of being known through intuition, the philosopher's word for immediate apprehension of something which cannot be demonstrated in the way in which, for instance, a theorem in geometry is demonstrated.

This, then, is our immediate purpose—to examine in a critical way a number of very varying opinions about the nature of good and evil, right and wrong. This will involve us in a discussion of what

is meant by free will, which is the corner-stone of moral conduct and in a consideration of crime (which is to the State what immoral conduct is to the individual), punishment and forgiveness.

How Ethics Help

That is the subject matter of the science called ethics, or moral philosophy, and it raises one final question which must be answered. That is: Will ethics make immoral men moral? The answer is: No. Morality implies the will to do what is right; the man or woman to whom the epithet immoral can be applied does not care about the rightness of an action. He or she just acts as the whim dictates—and will continue to do so.

Then let us reshape the question: Will ethics help someone who has a sense of duty or obligation to know better how to act in accordance with that sense, or, as we might express it more simply, how to do what is right? The answer to this is: Directly, no, but indirectly, yes; for we can usually recognize more easily what we have analysed. By an analysis of the nature of moral man and of right action we shall be stimulated to think; and considered thought is necessary before we can even begin to act in accordance with a principle which we can rightly call our own.

True morality is something intensely personal which certainly does not consist in following blindly accepted canons of conduct. You might live a blameless life, but you could not claim to act morally unless you had formed your principles for yourself. Moral conduct implies responsibility and responsibility implies a free and independent judgment, not a slavish following of tradition as convention.

Having dealt with these preliminary questions, the way is much clearer before us and we can start by examining a theory which has gained a great deal of favour among a large body of modern thinkers. This is a theory which purports to explain the nature of man's conduct in the simplest possible terms. It says in effect that men and women by reason of their nature can do only what they themselves desire to do.

Philosophical Scepticism

Thus, it is really a theory of psychology which does not attempt to approach the problems of right and wrong, but we have got to consider it very carefully because if we accept it we shall have to abandon all our preconceived ideas about moral man. Fortunately, perhaps, the arguments which can be brought against it are quite overwhelming.

First of all, what exactly does this first theory of ours mean, or imply? That the essential nature of man is such that he is capable only of acting selfishly. In other words, if you are faced with the choice between two actions, as in fact you are hundreds of times a day, for example, if you have to choose between staying at home to do

some job which needs to be done and going out to enjoy yourself, this theory suggests that your choice is not really a choice at all but that you are compelled by your nature to choose the alternative which seems more to your interest or the one which will give you more satisfaction in the long run.

"That's nonsense," you will probably say, "I may recognize that it is my duty to stay at home and do that job which needs to be done and I may choose to do so even though I don't in the least like doing it." In other words, you will appeal to the facts of your own personal experience to refute the theory and you will be quite right to do so. Any theory which does not explain or satisfy the facts of individual consciousness cannot be accepted as a true one.

Fear of Conscience

But, as you have probably expected, the protagonists of the theory have their answer ready. They say that fear of a bad conscience helps to determine our choice. Thus they say the apparent choice is not merely between staying at home and going out. It is really between staying at home (something disagreeable) plus a good conscience (something agreeable) and going out (something agreeable) plus a bad conscience (something disagreeable). All we do, they say, is to calculate as between these imagined pleasures and pain and follow the course of action which seems to us to give *the greater balance of pleasure* on the whole.

Such theorists even go a step further and reduce everything to terms of self interest. So they will say that if we have an opportunity to achieve our ambition we shall do so quite ruthlessly whatever pain and suffering achieving it may bring on others, providing, of course, that we do not think the pain of a bad conscience will outweigh the pleasure of achieving our ambition.

By now you probably see many of the implications of this theory of how mankind acts. Quite frankly we must face the fact that it is extremely difficult to disprove any statement of the nature of man's psychology. All we can do is to follow out the logical implications of a theory, the consequences of which, perhaps, those who first propounded the theory did not recognize. If the theory leads us to an absurdity, as you will probably agree this one does, then we can say that it is discredited and search for another more acceptable.

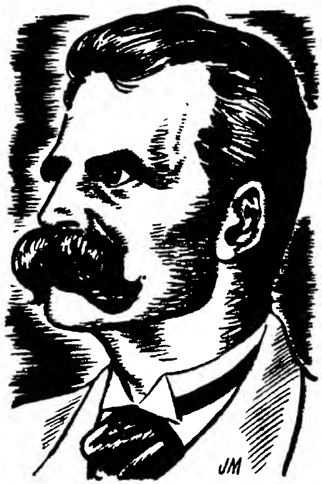
Logical Absurdity

This is the method of logic known as *reductio ad absurdum* (reduction to the absurd) and it is the most effective means of examining any and every theory which sets out to explain the conduct of mankind.

The first implication of the theory we have tried to explain is an absolute negation of the whole idea of duty. To put this more simply, if you accept it as a true interpretation of the nature of man,

you do not need to read any further because it follows from it that moral man just does not exist.

We have said before that every theory of conduct must satisfy the facts of our own consciousness if it is to be accepted and this one clearly does not accord with the facts of most people's consciousness. Most of us are conscious of the moral struggle that is the deliberate choice of duty in preference to desire, and our awareness of that struggle might be said to prove that it exists. If we were to admit that our actions were absolutely determined for us, that we could act only for self-interest, the struggle as such obviously would be non-existent.



NIETZSCHE
German philosopher who expounded the doctrine "Might is right," which inspired German military aggression.

Is that a sufficient *reductio ad absurdum* of the theory? Some think it is; others feel that it may still partly be true. They say that perhaps the moral struggle and the idea of moral action and duty are universal delusions, suggested to the man in the street by the leaders of society for the protection of the members of society.

Indeed it is obvious that the whole fabric of civilization is based on the supposition that the majority of mankind will do what it believes to be right; and the State punishes certain kinds of wrongdoing, thus enforcing a general line of conduct to a limited extent. But it seems fantastic to suggest that all men would act illegally if they thought they would not be found out, which is the logical extension of this theory of general conduct known as philosophical scepticism.

Many of man's actions are, however, necessarily selfish. After all, the interest of the agent (the term philosophers use to describe the doer of an action) is just as important as the interest of any one else, so that even on an altruistic explanation of conduct selfish actions are not inevitably wrong.

Now let us consider one or two developments of the theory. The most significant of these is the statement that might is right, a form of philosophical scepticism which has been applied with equally devastating results to the conduct of States and to the actions of individuals. It is the philosophy of

Nazi Germany, the philosophy, indeed, which has inspired many years of German imperialism and aggression. It was the philosopher Nietzsche who gave the fullest expression to the underlying doctrine, although he was by no means the only one seriously to hold the extraordinary views which have helped to produce chaos and destruction.

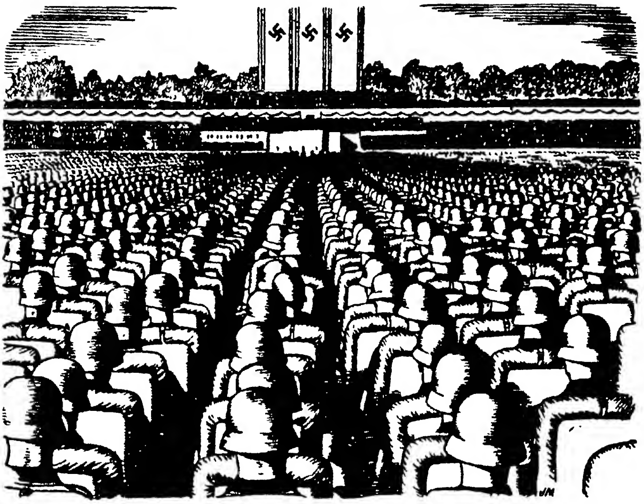
Nietzsche was either a lunatic or something very near it—certainly his life was spent in and out of a home for the mentally deficient—and it is one of the mysteries of modern times that his writings gained such a considerable hold on the thoughts and actions of a whole nation for so long.

Probably the only explanation which is worth considering is that the conclusions reached hold out hope of better times, of power and wealth, and no one really cared how those conclusions were reached, on what false hypotheses they were founded, and on what false inferences the deductions were made.

To describe the doctrine might is right as the corner-stone of this school of thought is, of course, an over-simplification of the facts. What Nietzsche and those who went before him sought to prove was that nature, by a process of evolu-

FREDERICK THE GREAT'S ARMY

Frederick the Great, King of Prussia, who extended his territory by acting on the principle that might is right, was an illustrious example to later German followers of this theory, which was elaborated by Nietzsche. Here is an artist's impression of Frederick reviewing his well-trained army.



HITLER'S ARMY

Slavish followers of a modern exponent of Nietzsche's doctrine. Hitler inspired the German people with fanatical fervour and a belief in their destiny as rulers of the world. For a time this fanaticism gave them almost irresistible power in pursuing their policy of expansion by aggression.

tion and natural selection, always chooses the strongest to survive, and, indeed, we must admit the principle of the survival of the fittest as an important and undeniable aspect of natural history.

If then, it is argued, nature provides only for the survival of the fittest—that is, of the strongest—it must be part of the divine purpose and therefore absolutely right that only the strongest should survive. The divine purpose will be fulfilled, it is said, when a race of supermen has been evolved, perfectly strong, perfectly ruthless and, therefore, perfectly good. Since it is right that strength should prevail, every man ought to struggle for his own supremacy in a world of war, crushing all those who presume to interfere with his progress.

Thus, every action is right, whatever pain it may cause, whatever suffering it may bring in its train, if only it conduces to placing the strongest at the head and ensures their survival. Conversely, every action is wrong which tends to the protection of the weak or to the circumscribing of the activities of the strong.

This is at once a complete analysis of human conduct and a

complete code of conduct deduced from it. In the history of mankind those philosophies have always been most popular which are not confined to theory, but propound also a definite course of action, especially if the trend of that action is to the doer's material advantage.

National Response to a Theory

Here was a call to arms to the whole German people and one propounded by a native philosopher backed up by the diabolical semblance of religious authority through the misleading identification of God's will with the course of nature. Perhaps it was not surprising, therefore, that the German people and their leaders, who persisted in quoting Nietzsche, were swift to respond. The doctrine gave the necessary ideological and authoritative background for a policy of ruthless aggression which otherwise would scarcely have found favour with the bulk of a whole civilized nation.

History indeed proves that such a background is necessary for any great movement, a strange paradox to those who foolishly maintain that the world of thought has little relation with the world of action or that philosophy has no influence on conduct. The greatness of ancient Greek democracy, the rise and growth of the Christian world and, in more recent times, the French Revolution and the emergence in Great Britain of the rights of the common people, owe their origin primarily to the philosophies which are their basis and of which Christianity has had the most widespread lasting influence.

It is significant that even the German philosophies cannot dispense with the idea of God, cannot override the doctrines of Christianity without giving some account of them. For Nietzsche Christianity was a vast heresy imposed on a gullible world by a weak race, the Jews, for their own protection by the medium of one of their own number, Jesus Christ.

They knew, says Nietzsche, that they were fated to extinction unless they could devise some means of protecting themselves. Let low cunning prevent the completion of a job which God and nature intended to be done by brute force. What better way than to sponsor a guide to conduct which would impose the protection of the weak as a matter of right and would achieve the restriction of the strong in the name of morality?

Why Might is Not Right

You may feel that it is scarcely worth while refuting a doctrine which is so contrary to the accepted and traditional thought of what we call the Western democracies, yet the fact that a theory is novel cannot take the place of proof that it is wrong. Therefore we must expend a few lines in proving how and why this theory is wrong.

First of all, it is open to the same objection that we put forward to the theory of philosophical scepticism, or rather to that form of it

which suggests that man's ideas of right and moral conduct have grown out of a conspiracy to protect the weaker members of society. In other words, even if history shows that might has always prevailed, this is no argument that it ought to prevail.

Man's Moral Sense

Again, the survival of the fittest is applicable to the evolution of nature and may have been necessary for the evolution of man, but it could not be argued justifiably from this that the survival of the fittest is right or that it represents a definite purpose. The two thoughts are not connected. As we saw at the very beginning, man differs from other kinds of living things by virtue of the very fact that he can make judgments about conduct, that is, by the fact that he is a moral creature.

We have examined a few of the most important explanations given of the nature of human conduct, even though we have found them to be unacceptable. We have examined them so carefully because the moral element in human nature is a factor which cannot be demonstrated; it can only be inferred. Indeed it is probably true to say that most self-evident truths can only be proved by their self-evidence.

But, of course, truths which are self-evident to some are not self-evident to everyone, so that it is essential to examine critically theories which deny the moral fact as well as those which try to explain it, especially when, as in the case of the two principal ones we have examined, they have been accepted by fantastic numbers of people and have affected so materially the course of human progress through their adoption by national leaders who have been in a position to give practical effect to them.

Our conclusions so far may be summarized by saying that any theory which seeks to express the moral part of man in any terms except those of morality is quite untenable.

We must admit the ideas of right and wrong and the moral motive as integral parts of the nature of mankind and as important factors in the determination of mankind's actions. As a result, we are now in a position to study two of the most vital parts of human conscience and the freedom of the will or, as it is more popularly called, free will.

Awareness of Duty

We speak of having a good conscience or having a bad conscience, and you will remember that the exponents of philosophical scepticism made great play with the pleasures of a good conscience and the pain of a bad one. Now a good conscience is the awareness of having done your duty or done that which you believe to be right; and no doubt this awareness of duty done does give the individual some pleasure and satisfaction.

Similarly, a bad conscience is rather akin to remorse; it is the

awareness of a duty left undone, or of a desire gratified which we know it was wrong to gratify. We can go a step further and say that, in fact, this awareness of wrongdoing may often cause pain.

Conscience and Judgment

Like every other word in the English language, the word conscience is used in more than one sense and is often misused and given a non-moral implication which does not properly belong to it. We say, for instance, that conscience dictates a certain course of action, and we say this as though we are conscious of some special kind of faculty, a certain moral sense distinct from the senses of touch and hearing and so on, and distinct also from the mind.

This is a case where a little reflection will show how the misuse of words leads us to a false conclusion. You have often used this very phrase or something like it, but if you examine yourself very carefully you will find that what you meant was that you judged that such a course of action was right. Judgment, of course, is a faculty of the mind and we shall in point of fact be right in assuming that every moral judgment is a judgment in the full sense of the term and implies a definite mental activity.

We can summarize then the true position with regard to conscience as follows. Conscience as a faculty separate from the mind and senses does not seem to exist. It is either a moral judgment relating to duty or else it is an awareness or consciousness of having done what is right, or, to go back to a phrase we used earlier, the consciousness that duty was preferred to pleasure in the moral struggle. This awareness of having acted rightly gives pleasure, but pleasure is not the motive which causes us to take a particular line of action.

We have dealt with conscience before free will because the analysis of conscience will guide us to a better understanding of the nature of free will. We have said that a good conscience may be ours when we know that duty prevailed in the moral struggle. That implies that along with our satisfaction at having done what is right, there is the knowledge that we could have acted otherwise, that it was within our power to have taken an alternative course of action. For why else should we be pleased that we have acted as we have? Surely there would be no cause for satisfaction if what we have done were the only course open to us.

Free Will

It is this freedom to choose between two conflicting courses of action that is called free will. Every time we act we exercise it so far as we are aware that we could have acted otherwise, and this applies to all actions, not only those which have a moral content.

Most of you would probably be content to take this for granted and it does not readily come to the ordinary man or woman in the

street to question this freedom of action or to investigate its nature. So let us ask ourselves a few questions which will show the way to the very real difficulties which prevent the proper understanding of this part of our make-up.

Influence of Environment

Are we really free to select the course of action we are to pursue? Has heredity no part in our choice? Does not our environment make an enormous difference to the course of action we are likely to pursue? We often have no control over our environment, which is something outside us and something we are very seldom in a position to choose even though we may be free to cast off the influence of a particular environment.

If we admit the influence of these two factors, heredity and environment, obviously the free will of which we are conscious is of rather a different kind, as it must be partly determined by these factors in every single instance of its operation and, so far as it is determined by factors outside ourselves, cannot be said to be entirely free.

Moreover, it is a law of nature that every event is absolutely determined by the chain of causes which precede it. If a bomb falls on the earth it has surely been launched by some agency and, what is more important, if this agency had not been present, it could not have fallen.

It is said that human action falls within the same category and that every human action is absolutely determined by the train of external events over which the agent has no control, among which heredity and environment, or the character of the agent and his outward circumstances, are important.

Your choice on this showing appears to be free only because you do not know the causes which have determined it. One everyday example will make this clearer. Suppose you are at a crisis in your life when there is the choice of continuing the even tenor of your ways or making some radical far-reaching change. Having made your choice you will think you have acted freely and according to your own judgment.

On the theory we have been considering, however, you yourself as an individual have no part in the choice which, it will be said, is determined by the kind of person you are and the circumstances in which you are called on to make the apparent choice.

Mechanistic View

This is known as the mechanistic view of human conduct. Its chief weakness is that it makes no distinction between actions and events. It presumes that the same laws which are applicable to inanimate things and to nature are also applicable to human beings, and this assumption is entirely without foundation. No proof has been offered in support of it, and it is no mere conceit on the part of human beings that they differ

materially from the animal kingdom and from other animate and inanimate objects.

We are thrown back on our original position of man as a moral animal, the only moral animal in the world. We are conscious of this distinction and our consciousness of it proves either that it is real or that it is a universal delusion. Even if we incline to the latter view it might be said that a delusion that is truly universal is one quite sound enough to act upon. We are not automata and our awareness of the fact is justification for assuming the truth of that assumption.

We can, therefore, reasonably abandon the mechanistic view of human activity, but we must make two concessions to it. We must allow that by no means everything which we could term human activity consists strictly of actions and that factors, such as heredity and environment, do play some part in influencing our characters and individual actions.

Let us examine the first of these two propositions more closely. When is an action not an action?

INFLUENCE OF HEREDITY AND ENVIRONMENT (I)

The theory that our actions are determined by heredity and environment has a good deal of truth in it, though, even so, we still have freedom of choice—to do what we desire or what we believe to be our duty. The slum children above are bound to be influenced by their dismal surroundings.

INFLUENCE OF HEREDITY AND ENVIRONMENT (II)
Compare these children playing in a happy and healthy atmosphere with the unfortunate ones on the opposite page. Their chances of developing a good character are obviously far greater than those of children reared in slums.

Or in other words, what phases of our activity are absolutely determined for us? Clearly any action to which I am literally forced, in other words, which is against my will, is not an action in the sense that freedom attaches to it or that it represents the result of a deliberate action of choice.

Even this statement cannot be made without qualification, for among those actions which may be said to be against our will a clear distinction can be drawn. First there are those actions which are forced on us by superior force. To take an extreme example, if you are caught in the up-current of a tornado you will be swept off your feet whatever you will. Similarly, if you fracture your spine you must retain a prone position, and this factor outside your control will absolutely determine your actions.

These cases are so obvious that they scarcely need stating, except to show that there are human actions which approximate very closely to events in which human conduct must therefore follow the course laid down by nature.

But what shall we say of that very much larger number of actions which are dictated by fear, either for one's self or for others? It is quite a conceivable position that

one might co-operate in the perpetration of deeds which one was convinced were evil in order to prevent vengeance falling on the heads of loved ones.

Obviously this much larger class of human activity is essentially different from those other actions where the agent is caught up in the forces of nature. But the unsophisticated answer is the same —that the person was not responsible for his acts.

Yet is this so? Surely the man who signs the death warrant of his best friend in order to save his own skin, or, conversely, who performs actions he believes to be wrong in order to save his nearest and dearest at least has this freedom of choice —he can do the action or he can refrain from doing it?

What he does in effect is to weigh in the balance the consequences and act accordingly. It is only the consequences which are outside his control, not the action, and the whole matter shows that in estimating the rightness of an action, or in willing to do an action, all the circumstances must be taken into account, the consequences as well as the antecedents.

Voluntary and Involuntary Actions

Here one more distinction must be drawn: that between voluntary actions dictated by the fear of the consequences and involuntary actions. If you fall down in a faint on hearing bad news you cannot be said to be responsible; the action is an event rather than an action. But if, on hearing the same bad news, you get drunk, although you may not be responsible for what you do under the influence of alcohol, you are responsible for exposing yourself to its influence.

So we reach the logical conclusion that actions are divided into voluntary and involuntary and that the latter are better classed as events, but the former always imply the exercise of free will.

Truth Behind Determinism

What then of the influence of heredity and environment? What is the germ of truth underlying the theory of determinism? It is surely that heredity or environment or both (summed up as the influences which have shaped your character) determine, on the one hand, the things you desire, on the other, the things which you believe to be right. But even with these determined for you, there remains a free choice between them: to do what you desire or to do what you believe to be your duty.

We have carried the analysis of human conduct as far as it can profitably be carried before analysing the nature of the moral judgment, and some of the varying ideas of good and evil which spring from this analysis.

At this point, therefore, we must examine and separate the several aspects of moral judgments, for we do not commonly judge simply that something is good or evil, we particularize the special way in which we approve or disapprove,

l this subdivision of the moral gment is a necessary part of n's mental activity. Thus, we erally class actions as either ıt or wrong, things as good or l, and motives as moral or noral. At any rate, these rough tinctions will act as a general de in considering what follows.

Moral Distinctions

[he real importance of these tinctions lies in the problem of relation between them. From at we have said it would seem follow that the rightness or ɔngness of an action may be luced from the consequences ich follow from it.

Similarly, it would seem that rality as such is concerned only h the moral motive and has no ınexion with the consequences of action except in so far as they ı be foreseen by the agent.

Since the consequences of any ion cannot be foreseen in their irety by human intellect, it lows that some actions per- med with the best possible tives may nevertheless turn out be wrong, and vice versa. It lows also that in any given cumstances one action and only e is right, though the right action y not be capable of being known h certainty.

If we accept this as a summary the nature of the moral judg- nt (and we shall later consider e or two views which disagree th it) it is reasonable to suppose ıt those actions are right which tend to bring about the Good and those actions are wrong which tend to diminish it.

It will be seen, therefore, why the search for the Good has been such a notable preoccupation of thinkers of all ages. If we can only discover what the Good consists of we shall at one stroke have solved one of mankind's greatest problems and we shall also have discovered a real key to duty and to the nature of right and wrong actions.

The first reaction of mankind to the challenge to define the Good has always been to turn to authority. We are mostly at heart quite naïve and as a race we prefer to be led, at least on those matters on which we cannot claim to be authorities. This appeal to authority is perfectly reasonable; for authority in whatever form generally expresses the results of past experience and the whole field of tradition.

Tradition in History

Historically it is tradition itself which has proved to be the first authority to which men have turned. And by first and historically we mean that it is on tradition that members of primitive or backward societies have always depended, and in some parts of the world still do depend.

All civilizations have tended to develop, that is, to progress from the unreflective to the reflective. In other words, they have come to think for themselves; and directly individual thought begins to be possible, the appeal to tradition and

traditional ideas of conduct ceases to convince. The reason for this is not far to seek. It is a truism to say that times change, yet times do change and any rules of conduct handed down by tradition can of necessity take no account of these changed conditions.

Primitive Taboo

Let us take a few concrete instances to elaborate our meaning. The simple taboo is sufficient for the most primitive societies of mankind; but once the tribe has acquired the first stage of mental development its members inevitably ask why? Alas for the taboo, there is rarely a satisfactory answer to be given. Once, no doubt, when the taboo was instituted there was a very good reason for it, but the reason has ceased to be operative with the lapse of time.

Appeal has then to be made to some other authority. This usually takes the form of a new system of laws incorporating many of the more primitive taboos. Most developing civilizations have had their traditional lawgiver, though often research shows that no single man enacted the whole of the laws, but that they grew gradually from custom and precedent and were finally codified by some great leader. Moses, Solon of the Athenians, and the author of the Twelve Tables of ancient Rome are notable examples.

Thus arises the first code of laws laying down general rules of conduct and prescribing penalties for various sins of omission and commission. But ultimately the code proves no more efficacious than the simple taboo. It loses its authority for the selfsame reason, namely that it takes no account of changing conditions and becomes, therefore, out of date. Men say "why should we obey the laws of our ancestors when they prohibit us from doing things which we believe to be right or allow us to do things which in our enlightened society we believe to be wrong?"

Again there is generally no satisfactory answer and although progressive changes are made to the laws to bring them more into line with contemporary thought, once they are altered they cease to have their former absolute authority.

Basic Idea of the Good

Consequently mankind is forced back on his own authority, or judgment, to determine in what the Good consists and what action is right in any given circumstances. We might summarize this by saying that ideas about duty and about right and wrong change progressively, but that the basic idea of morality and belief in an absolute Good as an end or purpose of human activity remains constant.

We have said before that a man can be said to have acted morally only if he has acted on his own initiative and by an action on his own responsibility. This, of course, implies that he must have made a particular and individual judgment. To put this truth in another way,

moral action implies thought, judgment and free will. Laws are highly necessary to ensure the safety and smooth working of society; but a literal keeping of the law is no guide to private or individual right action.

Philosophy of Aristotle

Aristotle, the Greek philosopher who lived well over two thousand years ago, was one of the first to formulate a complete scheme of moral philosophy. The argument he used was roughly as follows:—

The Good is that at which all things aim.

All men aim at happiness.

Therefore happiness is the Good of man.

This is an argument known as a syllogism, in which the truth of the third line is inferred or deduced from the first two lines. In this case no proof is offered of the truth of the first and second lines, or premises, as they are called. But few will quarrel with them. The first is really a definition of the Good; the second is immediately recognized as true in the sense that all men certainly do desire happiness, though they desire many other things as well.

But what is happiness? Aristotle was content to analyse a number of activities which give pleasure and concluded that man's happiness consisted in the full exercise of that function which is most peculiarly man's—the intellect—and happiness in the final event resolved itself for Aristotle into a sharpening and perfection of the mental processes at the expense of the sensual elements of man until his chief pleasure was found in pure thought, in the contemplation of truth and the nature of reality.

This is a form of perfectionism, in so far as mankind does not as a matter of fact achieve its greatest pleasure in the contemplation of universals. Man is a balanced mixture of the mental and the physical. He has a mind which is used for thought and perhaps increasingly used as the nature of man develops.

But there is also a sensual side of human nature which cannot be neglected or relegated. The senses are just as integral a part of every man and woman as the mind. Because the senses are often abused is no logical reason for saying that they ought to be subdued or held inferior to the mind.

It is surely true that every creature reaches its highest perfection when all its qualities are perfectly co-ordinated. Any philosophy which will commend itself to us must allow for this fact, for if it does not it will not explain the facts of consciousness. Aristotle was writing of men as they might be, not as they are.

Utilitarianism

Modern utilitarianism is based directly or indirectly on Aristotle. In its most developed form it has been propounded by John Stuart Mill, and has attained a great following among the people as well

as among professional philosophers. The reason for its popularity is not far to seek. It sounds right; at first glance it seems to promise a happy life for everyone, and above all it is compatible with the political philosophy of democracy. But, as we shall see, there is an interesting fault in Mill's analysis.

Happiness and Pleasure

The first form of the theory (similar to that formulated by Aristotle) is that the Good consists in man's happiness and that it is right always to produce the greatest happiness of the greatest number. Unlike Aristotle, who proceeded to propound an intellectual view of happiness, the utilitarians were unequivocal in allowing that happiness is pleasure, that is to say, a matter of the senses.

In this at least they were right, for human happiness can be defined only as a state of consciousness in which pleasurable feelings predominate. All efforts to show that happiness consists of something other than pleasure have failed, even though, as we shall see, there is an element of truth in the theory.

Pleasure, then, is the Good according to the utilitarians and it is our duty to promote it by all means so that it exists in the greatest quantity. The refutation of the theory in this simple form is not difficult. What evidence is there of the statement that pleasure is the only thing worth seeking?

Mill himself sought to avoid the difficulty by admitting kinds of pleasure. It is our duty, he said, to promote the pleasure of mankind but we ought always to prefer higher pleasures to lower ones. This, at first thought, seems in accordance with our everyday judgments. We often say that a person ought not to degrade himself by indulging in base pleasures, or we praise a man for preferring the pleasures of music and art to those of beer and skittles.

But if we reflect more carefully we shall see that pleasure as such does not admit qualitative distinctions. I can measure the amount of the pleasure of which I am conscious at any given moment; I can compare the quantity of pleasure derived from two dissimilar activities; but I certainly cannot claim to distinguish between a good pleasure and a bad one.

Degrees of Pleasure

If I do, or seem to do so, what I am really doing is adding something to the simple calculus of pleasure. I am judging the thing or activity from which the pleasure is derived, which is a very different matter. If I say that the pleasure I derive from listening to classical music is of a higher kind than the pleasure I derive from jazz, what I really mean is that I feel some pleasure from both activities, but that I judge classical music to be more intrinsically valuable than jazz.

When I do this I am postulating that something other than pleasure is good, which is very important indeed, for it takes away the very

foundation of utilitarianism, which is that pleasure or happiness is the only thing which ought to be promoted.

Utilitarianism clearly does not explain the facts as we are conscious of them in ourselves. If promoting the happy life of man does not fully explain duty, perhaps duty consists of promoting some other kind of life. What kind of life seems more reasonable to promote than a good life? So, it is inferred, duty perhaps consists of promoting morality.

Theory of Perfectionism

Whose morality? Presumably not our own only, because that would mean that we have no duties to other people. But it is obvious that the hard path of duty amounts precisely to preferring someone else's welfare to our own in many instances. So the answer must be the morality of other people or of mankind in general.

This theory (sometimes known as perfectionism) is really self-contradictory. If our whole duty is to promote the morality of others, and the whole of their duty is to promote the morality of others again, the net result must be an unending circle in which everyone is promoting someone else's morality, without any one ever desiring anything but morality from their neighbour's goodwill. And morality or goodwill is an empty meaningless thing unless it is expressed in terms other than itself.

In other words morality or goodwill is judged to be valuable in itself, just as pleasure is, but in a world in which there is action and feeling it cannot from the nature of things constitute the whole of the good of mankind, because it is a condition of its being known and recognized that it should promote the general welfare of man, including, we presume, the satisfaction of those of their desires which do not conflict with the welfare of others.

So far we have assumed tacitly that the rightness of an action is determined by the results it tends to bring about, and we have found great difficulty in determining what these results are. That they consist of the good of mankind is really only a restatement of the fundamental idea of duty.

Some thinkers have reacted strongly to this, pointing out in addition that results are unpredictable and suggesting that the rightness of an action does not necessarily depend on its consequences but must be judged right or wrong on its own merits without reference to results.

Judging an Action

This view demands only brief consideration. But although we shall reject it, we shall discover that it contains an unspoken element of truth which will guide us to a more accurate analysis.

First we must consider two technical terms which are often met with in writings on the subject. These are *a priori* and *a posteriori*. Both of these are Latin phrases which have been carried into the

English language. The former means literally "from the earlier," the latter means "from the later," so that it is easy to see how their meaning has developed. When we speak of *a priori* knowledge we mean knowledge which is apprehended immediately, without reference to experience; when we speak of *a posteriori* knowledge we mean knowledge which is derived from a consideration of the facts gained by experience.

The proposition "a straight line is the shortest distance between two points" is a good example of *a priori* knowledge, while the proposition "this is an inefficient machine because it has broken down under normal stresses" is *a posteriori*. We could not know that the machine was inefficient until it had been tested in the light of experience.

Moral Sense and Intuitionism

Those philosophers, therefore, who hold that the rightness of an action does not depend on its results, but is judged immediately without reference to consequences are propounding an *a priori* view of the moral fact. The view in general can take one of two forms. Either it can be said that man has a special moral sense (the moral sense theory) or that man inherits the rightness or wrongness of an action by a special function of mind (intuitionism).

The moral sense theory suggests in effect that the moral sense is a sort of sixth sense comparable with the senses of sight, hearing, touch, etc., and that this comes into play whenever the necessity to judge things or actions arises.

The truth seems to be that it is impossible to divorce an action from its consequences, as we shall see in the next chapter. What we have said here is enough to show that intuitionism as stated does not explain fully the nature of moral conduct and the moral judgment.

There is, however, one very important truth brought out by the theory of intuitionism: the truth, in fact, on which it is founded and which lends it its plausibility. That is, that some judgments are *a priori*, and some of these judgments are concerned with the value or goodness of things. Aristotle's theory that happiness is a reasonable goal of human activity is really an intuition; but it is an intuition of self-evident truth which is recognized as true by everyone if it is restated thus: that happiness or pleasure is valuable or good in itself as an end and not as a means only.

Pleasure Not the Only Good

What makes the utilitarian philosophies unacceptable is that they insist that pleasure is the only reasonable goal of human action. But in effect their argument is based on an intuitive judgment of the intrinsic value of pleasure. As we have agreed that pleasure is not even the only thing which men desire, how much more strongly can we agree that there are other goods in the world besides pleasure which are intuitively recognized

as valuable and as reasonable goals of right action.

This is a theory which seems to combine effectively the truths implicit in the utilitarian and intuitionist theories of moral conduct. The good of mankind consists of a state of well-being shared by all the members of society.

Realization of Value

This state of well-being (something more than happiness) consists of the realization of a number of goods which are intuitively judged to be good. Pleasure is certainly one of them. Goodwill or character is another. The realization of the cultural potentialities of the individual is a third. And so on.

These are all parts of the good of mankind. Actions are right if they tend to promote them, wrong if they do not. If two alternative actions both promote this well-being, that one is right which produces the greatest amount, or, rather, produces the greatest good of the greatest number. Our duty consists of promoting these goods and morality consists of a will to further their promotion.

We do not state dogmatically that this is the only possible analysis of the moral conduct of mankind. It is well supported and more logical than the others we have considered but, as we have said, the analysis of human conduct can only be inferred and not conclusively demonstrated.

The nature of human conduct and the analysis of moral man have almost as direct a bearing on the State as they have on the individual; for it is a false abstraction to speak of the State as if it were something separate and distinct from the individual units which compose it. The State is in fact the totality of the members of society considered as a whole.

Behind every system of government there is a philosophy. This is perhaps obvious, so we will proceed to analyse some typical forms of government and see how they accord with the aspect of moral man which we have considered.

Purpose of Government

First, omitting for the time the subject of internationalism, we must ask: "What is the purpose of government?" The answer, unless you presuppose the divine element in government as such, as few do now, is "to serve the interests of the members of the State," in other words, to help the individuals so to order and rationalize their endeavours that the greatest possible sum of good is available to them.

It is here that the first difficulty arises. It is difficult enough to determine the precise nature of the good of mankind. Once discovered it can be defined in only general terms, but the State is confined to particular actions.

Moreover, if the good or the end were agreed, there would still be ground for disagreement on the best means to secure it. Is it any wonder then that mankind has never agreed on the best form of

government and that even those governments which have proved themselves by results have always had to give place to others?

We must face, too, the problem of how far it is the duty of a government to regulate the private lives of the citizens; how far, for instance, it is the function of a government to promote conventional morality. Governmental excursions into private life are often termed interference, but failure to promote observance of convention is just as often called neglect.

Bentham's Formula

In practice Jeremy Bentham's formula "the greatest happiness of the greatest number" is the one which has been the inspiration of most modern governments and, by implication, the same principle has been applied to most, if not all, the governments of civilized man so far as they have existed for the benefit of the members of the State and not for individual profit. But even if the basic formula is agreed there still remain three great problems in dispute.

First, is the pleasure of the subject to be the only matter for consideration, as our formula implies? Ought not a government to promote for the members of its society some of those other Goods which we have tried to show are intuitively recognized as good in themselves; in other words, promote an intrinsically valuable life as well as a happy one?

Secondly, if this is agreed, what form of government can bring about the desired end?

Thirdly, if this is also agreed, what are the means most likely to result in the greatest production or the best possible distribution of these Goods, material or immaterial?

There will not be universal agreement on these problems until every single member of the race of mankind is perfectly enlightened, or until man has acquired the qualities of wisdom and prevision which are usually attributed to God. But as in the meantime man must live and, in the present order of society, be governed, an interim judgment must be formed and acted upon.

Greatest Good for All

The answer to the first problem depends on what analysis of human conduct you adopt. If you agree with the argument laid down in the preceding pages that men desire other things beside pleasure and that the Good is a general term of which the parts are qualities or particular Goods intuitively recognized as valuable, then you will relate this opinion to government. You will uphold that it is the duty of a government to ensure the greatest possible satisfaction for the members of its society consistent with the principles of justice, which is equality of consideration.

It follows from this that the members of the society should be educated by the agency of government to appreciate the enjoyment of those things which are judged to be good in themselves.

The third problem (What is the best means to bring this about?) must remain a subject for discussion, having regard to the particular circumstances of the case. There can be no simple or unambiguous answer because the circumstances are constantly varying, but the problem is essentially a non-moral one once the end has been agreed.

It is similar to but much more difficult than the problem of a man who wants to find his way from point A to point B by the quickest possible route. There may be doubt or disagreement on what is the quickest route, but no one doubts that there is one route better than all others, though, as the time element is included, the shortest route may not, in fact probably will not, be a straight line joining the two points, but one which avoids boggy ground and other obstructions which can be known only by those who are familiar with the terrain.

So it is with a government. If the end to be attained is known, the best way to reach it is a matter of experience and experiment.

We revert, therefore, to our second problem, the only one of the

COURT OF AN ABSOLUTE RULER

L'Etat, c'est moi, *which means "I am the State," sums up the idea of absolute monarchy. The words are those of Louis XIV (here seen receiving a foreign ambassador), absolute ruler of France at the height of her power. In France, as in many countries, despotism was the prelude to democracy.*

three remaining. What is the best type of government? We will analyse the background of the main types of government as we analysed individual human conduct, in order that you may have the facts before you upon which a sound judgment can be made.

Absolute Rule

Historically, the earliest form of government is the absolute rule of one man. In various forms this type has survived through almost all the stages of civilization under the guise of absolute monarchy. It was well established in medieval England and generally in the states of medieval Europe.

Under the modified guise of dictatorship it has appeared in modern Europe, in most countries as a reaction against an unsuccessful experiment in democracy. The civilizations of the East and of Asia have all known despotic rule. The tyrants of ancient Greece, from whose government we derive the modern use of the word tyrant, and the chieftains of African tribes all fall within the same category.

In varying degrees they have all held the reins of government in their own hands with undisputed authority, and have exercised powers of life and death over their subjects without reference to a code of laws based on precedent, or to trial by the accused's equals.

Because the civilized world has become anti-monarchical, or at any rate allergic to the idea of absolutism, we tend to look on absolute rulers as tyrants, selfish, cruel and misguided. That is very far from the truth. In the history of the world absolute autarchy has frequently been associated with periods of great prosperity and has been allied with a good standard of living and moderate happiness on the part of the subjects. Why, then, have modern dictators so monstrously failed to live up to their traditions, and what is the philosophy of absolute monarchy? There is no simple answer to these questions, for there are two kinds of absolute rule which are entirely different. One is the hereditary monarchy in which the title to the throne is passed down from father to son without reference either to merit or suitability.

Divine Right of Kings

The only theory on which this can survive is that of the divine right of kings, scarcely one to which the adherents of democratic tenets will subscribe. Yet for centuries the population of Britain believed in this divine right. The successful and brilliant Ptolemies of Egypt held their throne by virtue of it, and many chiefs of primitive tribes held undisputed and effortless authority through the same tradition.

The simplest theory of the divine right is that God is the father of the first king of the line and that his divine qualities are passed down from generation to generation; in a more mature society the theory may only be that divine qualities

DIVINE RIGHT OF KINGS

The theory of the divine right of kings maintains that godlike qualities are found in a ruling family and that these give them the right of absolute rule. Charles I of England claimed this right and the above drawing illustrates the well-known incident, where he tried to overrule the privileges of the people by entering Parliament to arrest five of its members.

reside almost by accident in a royal family.

There is little logical justification for this theory, except that its assumption in practice has assured some degree of internal peace to relatively primitive societies at every stage of history. If divine right is attributed to a ruling family, what can it avail, it is said, to dispute their rule?

Directly the people reach maturity of thought, the authority of the so-called divine right is destroyed and with the departure of its authority any claim which it might have to practical consideration disappears also. In brief, then, we may say that historically absolute kingship is part of the early development of society and belongs essentially to an unreflective and uneducated people.

Modern dictatorship, another form of the same theory, is really very different, because here there is no question of inherited qualities nor of divine right. In ancient Rome a dictator was appointed at a time of crisis by popular vote to have absolute power for a limited period and a limited purpose.

The same theory seems to have been behind the rise of the modern

dictators of Germany, Italy, Spain and so on, the only trouble being that once such men have established themselves they will not allow themselves to be dislodged. The fall of Mussolini is greeted with shouts of: "Down with the tyrant," "the end of a rat's career" and other such expressions of thanksgiving; but there is nothing inherent in the nature of absolute rule to deserve these appellations.

The theory, as you may have deduced from the analogy of ancient Rome, is that in times of crisis it is essential that there should be a free hand in government. Speedy decisions must be taken and those decisions must be ruthlessly executed. There is no time for the stately deliberation of parliament.

Given that the end is agreed, it may be said that the rights of the individual are abrogated and expressed in the will of the dictator, and it should be noted that the most democratic of countries give exceptional powers to their Churchills and their Roosevelts at times of crisis.

Qualities Needed by an Absolute Ruler

On behalf of dictatorship as a theory of temporary government, it may be said that in practice too many cooks spoil the broth and the wheels of government turn faster when they revolve in response to the bidding of a single man.

But think what is required of an absolute ruler. In order to be philosophically justifiable he must be a man of absolute goodwill, of perfect selflessness, of incredible wisdom and prevision.

If his mandate is Jeremy Bentham's to secure "the greatest happiness of the greatest number" he must know by intuition what his people desire and what desires should be satisfied in order to secure the greatest happiness on the whole.

He must be able to recognize the Right and the Good in every conceivable circumstance. In brief, he must possess all the qualities normally attributed to God.

Failure in Theory and Practice

Thus it may be said that absolute rule fails in theory as it does in practice; its apparent temporary success in some societies seems to be due to the faith which the people have in the divine qualities of their leader. It was this faith in the superhuman qualities of Hitler which enabled him to weld the German people into a great fighting force, particularly as they were filled with the theories of Nietzsche and his fellow philosophers.

Unless these divine qualities are attributed to a single human being there seems no logical reason to justify one man being entrusted with the destiny of any society. The temporary exceptional powers granted by the Roman and modern democracies to individuals are of a very different order, for they are of an executive variety and are granted only within certain limits for a prescribed and limited purpose.

As a vast experiment in the evolution of government, note must be taken of the feudal system which prevailed for so long in medieval England. The feudal system in its inception appears to be a form of absolutism or autarchy, for it was founded at a time when the divine right of kings was accepted without reservation and the king was the absolute head of the feudal system.

Even so, it had certain distinguishing features which separated it quite sharply from other forms of absolute government. The basic theory of feudalism was that the barons gave service to the king in return for his protection and that the retainers of the barons, by which is meant all the citizens of the country except the serf classes, swore allegiance to the baron in return for his patronage. That is to say, there was a definite *quid pro quo* and the real power in the country was wielded by the barons, who represented a kind of aristocracy.

Originally it was the king who granted the barons their estates, so that they ultimately derived their power from him, but by the time the system had been in force for a century or two the royal title to the land came to be forgotten and it was by no means unknown for the barons to question the king's authority. Magna Charta was the

FEUDAL ENGLAND

In England the feudal system proved a foundation for democratic government. Under this system the barons gave service to the king in return for protection, and all other classes, except the serfs, swore allegiance to the barons in return for patronage. Even the serfs were usually treated fairly. This illustration shows a nobleman on his deathbed emancipating his serfs.

tangible result of one of these deviations from authority.

Perhaps it is significant that the system lasted in its entirety longer than other systems of government and proved a solid foundation for the rise of British democracy. It might have survived still longer and had greater influence if it had allowed any place for equality or for the equal rights of mankind, a conception which has dominated modern politics.

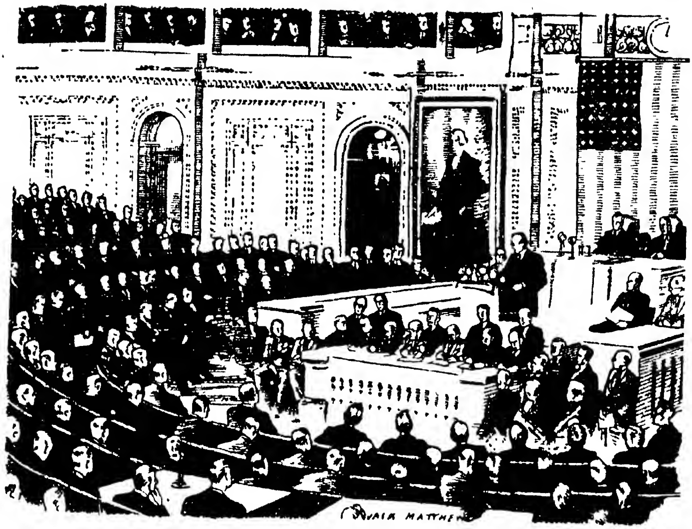
The next stage of government is marked by the systems known as aristocracy and oligarchy. Aristocracy means government by the best people, oligarchy, government by the few.

The theory that the best should be entrusted with government is commended at first glance, because it seems reasonable that the people as a whole should be content to entrust their direction to those few who best deserve their confidence. In practice, however, the difficulty is to determine who are the best or the few to be selected.

On what basis can this selection be made? Plato, the greatest of the ancient Greek philosophers, was quite definite in his answer to this. He said that the Golden Age would

DEMOCRACY IN THE ANCIENT WORLD

The Greek City States, which were at the height of their power about 2,400 years ago, are one of the earliest examples of true democracy. Athens was the most illustrious of the City States, and Pericles the most illustrious of Athenian statesmen. Here Pericles is addressing the Athenian Parliament.



DEMOCRACY IN THE MODERN WORLD

The democratic tradition of the Athenians has been resurrected in the modern world. This scene from a joint session of American Congress is the modern equivalent of the scene from ancient Athens on the opposite page.

mature when philosophers were kings. Let there be a school for government in which philosophy was the only subject of study and let those who proved themselves to have assimilated most deeply the principles of philosophy be chosen to govern the people.

But who is to select the entrants to this exclusive school? Plato himself could not provide a practical answer to this. Also, would modern people be content to have their government composed entirely of philosophers? Surely not unless they themselves were philosophers.

What, then, is a practical oligarchy? Unfortunately, history has produced few oligarchies in the strict sense of the term which can be said to have justified themselves.

If the best or the few were the wisest all would be well, but in practice every oligarchy has been composed of a landed aristocracy or of an aristocracy of wealth or birth. Wealth, land or birth imply vested interests, even in the case of recent British history, where we have grown accustomed to speak of a governing class or of a ruling aristocracy.

We may summarize our position, then, by saying that the theory of oligarchy is good, though impracticable, but it represents the

VOLTAIRE

Eighteenth-century French philosopher whose works fostered the spirit which inspired the Revolution.

next stage in the evolution of government, and marks an advance on absolute rule because it admits the possibility of more than one man being qualified to rule, and it grants rights as individuals to members of the State other than the absolute ruler.

The third and perhaps final stage is democracy—the rule of the people by the people and for the people. It has many forms, of which we shall only mention a few, but it is by no means modern, though it does represent a late stage of civilization.

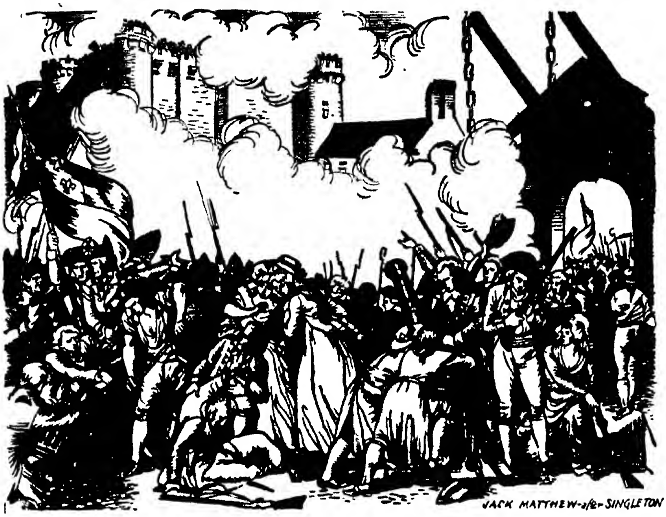
Let us remember, however, that the Greek City States which flourished two thousand four hundred years ago were more perfect examples of democracy than anything the twentieth century has produced, and let it be noted too that the culture of the Greek democracies was as high as our own; their ideas on all subjects except mechanical ones as advanced as our own.

Democracy is indeed the symbol and the inspiration of a very advanced stage of culture, for it attributes equality of consideration to every citizen in the State. It says in effect "Let all men be free and let all men be regarded as individuals having equal rights in the State."

In the modern world the French Revolution, with its slogans of fraternity and equality, was the

ROUSSEAU

The French philosopher who insisted that all men were born equal and should, therefore, have equal rights.



STORMING OF THE BASTILLE

This event has become a symbol, in the minds of Frenchmen, of the freedom they gained as a result of the French Revolution. The date of the fall of this fortress of oppression (July 14) is honoured as a national day of rejoicing.

dawn of a new era. Then it was the philosopher Rousseau who expounded the theories on which the spirit of revolution was based. Since then there has been a spate of philosophers of democracy, not confined to Britain and America, but including the great international philosopher Marx and his many Russian followers.

But who would be bold enough to say that true democracy has ever been attained? Who will forecast when it will be attained? Why the delay? The answer is simple. It revives the conceptions of freedom and equality. What do they mean? Is it possible that the twin ideals of an enlightened government should be obscure?

Indeed they are far more than obscure. They defy precise definition and the difference between various forms of democracy (democracy as in the United States or in Britain, Socialism, Communism and many other isms) depends on the various interpretations which they put on these two ideals.

Freedom, we have implied, is the principal concept behind the idea of democracy and presumably what is meant to be implied by freedom is the free exercise of free will. In the philosophical sense in which we have discussed free will

in an earlier part of this chapter this would amount to saying that freedom consists in the individual being competent to choose what course he shall pursue wherever there is a choice of courses open to him.

Any mechanistic view of action precludes the freedom which is the freedom of democracy just as much as it precludes the exercise of free will. That again amounts to saying that the freedom of democracy attributes to the individual full responsibility for his actions and treats him as in the full sense of the term a moral animal.

One would say that the freedom postulated by democracy is the very quintessence of man's nature, the prerequisite necessary for his full development as a man. Thus philosophical, or as modern writers tend to say, ideological freedom is, because of this, one of the principal Goods which we recognize as valuable in itself and as an end.

Democracy and Freedom

In so far as democracy and freedom are united, democracy must be the best form of government and must represent a considerable forward march in the development of mankind compared with oligarchy or absolute rule.

These observations may help to explain a situation which desperately needs clarification, for more muddled thinking has been produced by the concept of freedom than by any other single idea.

This confusion of thought arises because men insist on regarding freedom as an immediate end of practical politics and are not content to look on it as it is, as an ideal of theory to which practical actions may be directed, but which, in the present state of society, cannot immediately be attained.

Attainment of Freedom

Why cannot freedom be attained immediately? Because, it seems, the whole of mankind is not responsible. There are still millions of people who are unable to grasp the problems involved, who have not (through no fault of their own) attained the status necessary for the exercise of freedom without endangering the whole fabric of society.

In fact, as we have seen, we are never free in the full sense of the term. Your character, your heredity and your environment, all play their part in determining the circumstances of your actions even though we have concluded that you are able to exercise free will in the final event.

Every Act of Parliament, every law, every tradition and convention is a shackle which fetters complete freedom of action; but who would be bold enough to suggest that society could be suddenly divorced from its laws and statutes without its whole fabric crumbling?

We, therefore, get muddled thinking from many, amateur and professional, who seek to encourage their readers or listeners to expect something which cannot be realized.

THE MOTHER OF PARLIAMENTS

The British Constitution is the oldest of the democracies of the modern world; the House of Commons is its corner-stone. The spirit and tradition of Parliament are evoked by this scene from a debate in which a member addresses the House, while members of the public listen from the gallery.

They say glibly that freedom must never be allowed to degenerate into licence, but this is an utterly meaningless distinction. If there is freedom to do right, there must be equal freedom to do wrong.

Freedom and Licence

So far as you are a fully developed moral creature you will no doubt choose to do what is right as you see it in any particular circumstances, but whether you do this or not is a test of your morality, not of your freedom. If you are not allowed to do what is wrong you cannot claim credit for doing what is right, so that without licence freedom is meaningless and attributes no real responsibility to the individual. All the same, there is not one among the peoples of the modern democracies who could reasonably argue that the time has come for the abolition of law.

In the meantime freedom must remain a poor compromise and be translated "as much freedom as is compatible with the furtherance of the greatest good of the greatest number." Democracy in practice gets over the difficulty by saying that in a democratic State men are governed by those they have elected; but if your freedom is necessarily curtailed, it does not make your freedom any the more absolute because it is curtailed by representatives of the people.

There are some who have begged the question completely and have defined freedom as freedom from want or freedom from unemployment, but, however desirable, these freedoms clearly have little connexion with the freedom to exercise free will which is the philosophical background of democracy. These freedoms are really part of social service, part of the job of distribution of a society's surpluses and aggregates which other forms of constitution tend to accumulate at the disposal of a few only.

What we have tried to say is that freedom is philosophically an ideal for mankind, a consummation of the moral nature of man, that it is partly embodied in some democratic constitutions, but that its full attainment is incompatible with the warring instincts and the conflicting natures of individuals which demand the fetters of government in order to ensure internal peace and equitable distribution.

Ideal of Equality

Now a few words about equality. Equality is in much the same category as freedom. It constitutes an ideal, but not a practical or realizable goal. How often have we read: All men are born equal? Of course all men are not born equal. They are born with differences of heredity which nothing in this world will equalize.

All that can be done in a practical way is to strive to equalize their environment, in other words, to give them an equal opportunity. But an equal opportunity for what? Surely the answer must be for the realization and enjoyment of the intrinsically valuable things in life.

It cannot mean, as some would seem to suppose, that every child born in a State should be trained to be a mathematician, a philosopher, or an artist, but only if his or her intellect and qualities are adapted to making use of this training either in the sense of self-realization or in the service of other members of society.

We have probably said enough to show that absolute equality cannot be a point of practical politics, because it is not possible. Like freedom, it is an ideal or criterion of right. In effect, in modern society the cry of equality is an emotional rebellion against the glaring inequalities of the past; yet, as we have seen, it does also represent a considered and important doctrine.

Is democracy the final goal of mankind? Scarcely. Rather, absolute freedom is the final goal and democracy an intermediate stage. In what circumstances, then, would absolute freedom be possible? It would be possible if every man and every woman were truly responsible and were motivated by unselfish desires and had what Kant called the goodwill.

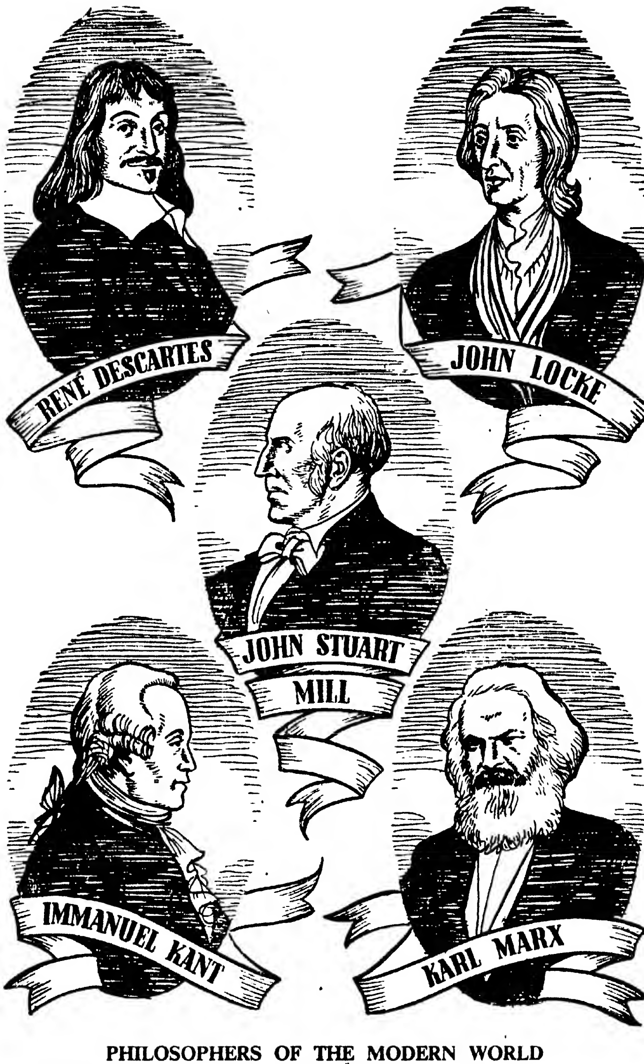
Achieving Anarchy

All that is, perhaps, partly a matter of education and training, reflection and consideration. Then, perhaps, mankind could govern itself in the sense of needing no restraints except self-imposed ones, not self-imposed in the sense of being imposed by elected members of the people, but self-imposed in the sense of being imposed by the individual on himself as a matter of deliberate choice and as a result of the exercise of his free will. That would be a state of anarchy—absence of government.

Progress of Mankind

This state may be realizable in the future, for of one thing there can be no doubt, that the idea of the Greek philosophers that everything is in a state of flux is true in the absolute sense, and the moral nature of man is no exception to that rule. Progress in relation to mankind is not so much a matter of mechanical invention and discovery, but is concerned rather with the development of the intellect, which involves the emergence and realization of the moral part of man's make-up.

There is a wide gulf between the taboos of primitive man and the statutes of democracy. The gulf is the measure of the gap between the moral development of primitive man and that of modern man. The future will show how the gulf between the present state and the full development of man's moral nature will be bridged. To say that it will be bridged is not only a matter of faith, but it is the statement of a reasonable goal or end based on the recognition of morality as one of the principal attributes of mankind and one of the Goods which are recognized as valuable in themselves and as a part of the complete life.



PHILOSOPHERS OF THE MODERN WORLD

Above are five great philosophers whose work and theories have made valuable contributions to thought and knowledge in the last three centuries.

CHAPTER SEVENTEEN

MAN'S INHERITANCE OF KNOWLEDGE

The nature of reality. How the senses deceive us. Primary and secondary qualities. Starting-point of philosophy. The early Greek philosophers. Theories of Plato and Aristotle. Interpretations of the idea of justice. Punishment and vengeance. Nature of truth. Theory of causality. Philosophy of history. Does history repeat itself? Man's ultimate freedom of choice.

THIS chapter is an introduction to a few of the principal problems concerning man and the world he lives in which he has set himself to solve, but which have not so far yielded absolute or definite solutions. One question which philosophy sets out to answer is: What is the nature of reality? Another question closely linked with this is: What is knowledge? or How much do I really know and how do I know it?

Unlike the questions involved in the analysis of conduct, which we discussed in the previous chapter, these are questions which do not ordinarily confront us in everyday life. Every one of us at some time or other has got to find an answer to the question: What ought I to do? But there is no similar imperative necessity to discover an answer to questions such as: Is that table or that tree, strictly speaking, real?

We tend to take everything in the external world for granted and always act on the assumption that its reality corresponds with our impressions of it, that is to say, with the impression it makes on our senses. I can see this table, we say, therefore it exists. I trust my senses, my sensations of sight, touch and hearing, and there seems no reason why I should doubt the impressions they give me. The table looks brown in colour, oblong in shape; therefore we say that it is brown and oblong, and its colour and its shape we attribute to it as surely as we do its simple reality.

Before you can really appreciate the problems involved or understand the implications of the very many theories of reality which have been propounded by philosophers, it is necessary that you should have the prerequisite for their comprehension, and that prerequisite is scepticism or doubt. So the first thing we will do in this chapter is to show how the senses are discredited: how it is that men have sought for a reality which is independent of the senses and can be known without reference to them.

Consider that brown oblong table which we were discussing. Is it really brown? Suppose you shine a green light on it, the brown oak stain will appear grey. Suppose you look at it just before you pull the curtains at nightfall, it will appear

almost black in the dim light. So it would seem you have a choice of three colours, grey, brown and black. Why choose one in preference to the other two? Presumably because that is the colour which it seems to have in the light in which you most often see it.

How Colour Appears to Change

You may possibly remember buying a piece of cloth or a garment and saying: "I should like to see this in the daylight," the implication being that the cloth is one colour, say black, in the artificial light of the shop and another, say blue, in the sunlight. Yet we say with absolute certainty that the colour of the table is brown, that the cloth is really blue. But that cannot be so, because if the colour which strikes our senses at any particular moment is its real colour, then the table is sometimes brown, sometimes grey and sometimes black.

Now it is obvious that a quality which is one thing at one moment and another at another cannot be described as part of the reality of the thing itself.

Thus we reach the conclusion that the table is not really brown, but only that it seems brown to us at one time and grey to us at another; and this you will see is only another way of saying that the brownness or greyness is not really part of the table, but resides in the eye of the beholder. That is roughly what the philosophers mean when they say that the colour of an object is subjective and not objective.

In this way the door is clearly opened to serious enquiries about what is the real nature of the things which we see, or think we see, in the world about us. We may go further and say: If we do not know what is the colour of the table, do we know anything at all about it? Can we trust our senses to give us the slightest indication of real knowledge? Must we exclude what we see and hear and feel entirely from our calculations and rely only on the results of our thinking, on the activities of the mind rather than of the senses?

Primary and Secondary Qualities

The quality we have discussed so far, namely colour, is what the English philosopher Locke called a secondary quality. His distinction between these and primary qualities is one of the most fundamental problems with which philosophy is concerned. According to Locke, the secondary qualities include sounds, smells, tastes, colours—in fact, all the qualities which we apprehend by the senses—and these are purely subjective.

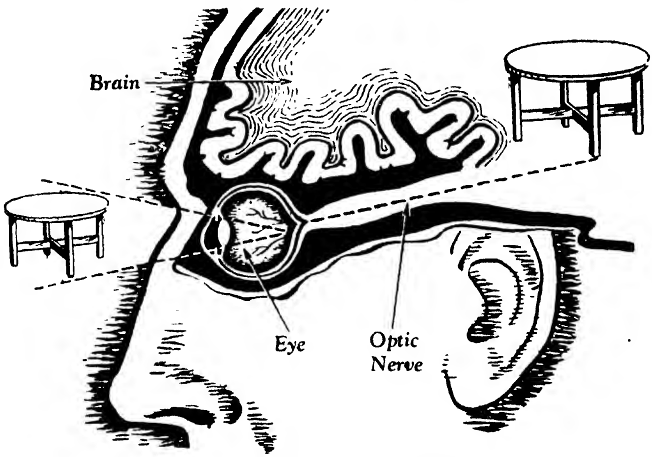
By contrast, said Locke, some qualities are capable of being measured and estimated by science, particularly those such as the size and the solidity of a body, whether it is in motion or stationary, and the number of its parts. These he called primary qualities because their nature can be checked by mathematical reasoning unbiased by the misleading criteria of the

senses. Our ideas of these qualities, according to Locke, do correspond with real qualities of the objects concerned. Locke's theory is not supported by modern science; colour is capable of being measured by the spectrograph; we can refer to one instrument or another to check most qualities of things. But, of course, the underlying doubt as to the reliability of sense impressions is not affected.

We must take scepticism still further. Even if you admit the distinction between primary and secondary qualities, it does not follow that sense impressions of the primary qualities are reliable. Are we always sure that our impressions of extent and solidity and the other primary qualities correspond with reality? We have proved definitely that our senses are misleading so far as they are concerned with secondary qualities, but can we ever be sure of them?

There you have the basis of scepticism from which one might say philosophy springs. That was the starting-point of the great French philosopher Descartes, who lived in the first half of the seventeenth century and who has exercised a great influence on all later thought.

His conclusion was that the only thing in the world which he could not doubt was his own existence as a thinking being. He wrote, as all learned men did at that time, in the



EVIDENCE OF THE SENSES

We are aware of the world around us through the activity of the senses. When we see a table the image falls on the retina and sets up impulses which travel along the optic nerve to the part of the brain which interprets it.

Latin language and he expressed the conclusion of his reflections in the words: *Cogito, ergo sum* (I think, therefore I am). The very fact that he was able to doubt was for Descartes, as it will be for most of us, adequate evidence of the fact that he existed, not necessarily that he existed in the material sense of the term, but only that he existed as a thinking organism.

Now, asks Descartes, does this one hard bed-rock, this single fact of absolute knowledge, help us to a clearer understanding of the limitations and extension of knowledge itself? According to Descartes it does, because the thought process of which I am conscious is awareness of something imperfect. But we could not be aware that something was imperfect unless there existed also something perfect by comparison with which the individual is imperfect; and this idea of a perfect infinite reality is something comprehended by the mind entirely irrespective of the senses.

Idea of God

Descartes thought that the fact that we have this idea, quite a definite and positive though not a detailed one, would be inexplicable unless we supposed that a real Being exists which is the original of our idea. Obviously we could not derive the consciousness of our own imperfections merely from ourselves. The idea, then, must be derived from a reality outside ourselves, and the Being or God which is the original of this idea must be real, because if it lacked reality it would be imperfect.

Such is the basis of the theory which holds that the objects of thought have true reality, while the phenomena of the senses have only subjective reality, in other words, are only real because we make them so. Before we proceed we must consider another quite different theory of ideas—the Platonic theory—which has really very little in common with the theories of Descartes and his successors, though the two are often confused.

Greek Philosophers

Plato is most readily intelligible against the background of thought of earlier Greek philosophers, and his contribution to human knowledge was carried many steps further by his successors, notably by Aristotle. In many ways Plato was one of the greatest of all the philosophers whose work is known to us. Many will have it that he was the greatest. Certainly much that he wrote over two thousand years ago stands unrefuted today.

The ancient Greeks had no storehouse of knowledge from which to draw. They started as it were from scratch and worked out their theories of reality from first principles. Those who preceded Plato were for the most part devoted to theories which appear fantastic in the light of modern thought.

What impressed the early thinkers was that nothing in the world as recognized by the senses had any permanence. It was always in a

PLATO AND ARISTOTLE

Plato was one of the greatest of the ancient Greek philosophers, and his work was carried on by Aristotle, one of his disciples. Plato's writings have influenced the world of thought more than those of any other philosopher.

state of coming or going. You might name the time when the elements of the unborn child came together in the mother to be; trace a continuous story of growth and development followed by decay; and at a given moment you could say that life was extinct. But the corporeal substances of the body lived on, or rather changed into something else, as the water which modern science tells us forms a large proportion of the total weight of any body evaporates and the remaining solids start on a new journey in the form of dust.

Ceaseless Process of Change

It appeared to the ancient Greeks that this was true not only of living creatures but of everything else in the world which had extent and solidity. We know now that what they propounded as a theory is borne out by the findings of modern science. For there is nothing in the world animate or inanimate which is not slowly changing with the passage of time. Even the ocean, which perhaps above all other things we should regard as permanent, is constantly changing in the sense that it is not composed of the same particles of water today as it was yesterday, for over the oceans, as over the land, there is in being an unceasing process of evaporation and replacement.

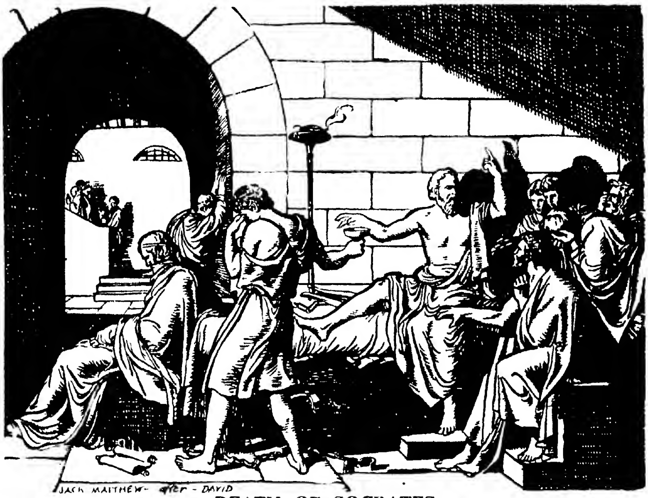
These and similar facts of science, dimly apprehended as they were by the early Greek philosophers, impelled them to seek for one element into which and from which all things were changed; in fact, a single element which would be permanently real and true in a world of changing phenomena.

Having reached so far tentatively after a solution of a problem which was to baffle philosophers nearly two thousand years later, they failed in the main to offer a solution worthy of very much consideration. One found the answer in fire, another in air, another in water, theories too unsophisticated for modern thought. Such theories failed, moreover, to satisfy Plato or Socrates, whose pupil and disciple Plato was.

Socrates Interpreted by Plato

Socrates was a philosopher and teacher of Athens, whose written work, if there ever was any, has not come down to us. But a great deal of his thought is immortalized in the writings of Plato, so that it is difficult to say where Socrates ends and Plato begins and when we speak of Plato we shall mean Socrates as interpreted by Plato. Plato accepted without reservation the theory of the earlier Greek thinkers that everything apprehended by the senses was permanently in a state of change.

In particular, he accepted the theory of Heraclitus, who made the well-known point that you can never step twice into the same river, in that the particles of water which make up the river today will be different tomorrow. An enthusiastic follower of Heraclitus went even



DEATH OF SOCRATES

Although we have no written work of Socrates, his life and teachings were recorded by Plato, the most famous of his pupils. Charged with corrupting youth, he was condemned to death by the customary drinking of hemlock.

further and said that you can never step once into the same river because at the very moment you are stepping the river into which you thought you were stepping has changed!

This, says Plato, is all very true of the world of sensation. Admittedly everything we apprehend by the senses is in a state of flux, but there must be another world which is by contrast real; a world of realities apprehended by the mind. Here we see how nearly Plato approached the position of comparatively modern philosophers such as Descartes. These permanent realities apprehended by the mind, but not by the senses, Plato called the world of ideas or forms and hence his theory is known as the theory of ideas.

Nevertheless we shall be mistaken if we assume that he meant that it was our ideas in the modern sense of the term that are real. The ideas or forms are the permanent prototypes of objective realities themselves, of which the world of phenomena, the things we apprehend by the senses, are copies.

Let us take a specific example. Humanity is something real and objective which I can apprehend only by the exercise of reason. Plato would call humanity an idea. Individual human beings are copies of this and cannot be spoken of as having objective reality. The form

or idea is the proper object not of the senses but of the understanding, yet we must be careful to remember that this does not mean that it is what we call a notional concept, and by no means depends for its existence on our thinking of it.

Aristotle and the Universal

Aristotle, a pupil of Plato, agreed with him in main principles. He criticized only Plato's theory that material things are copies of eternal realities. He went a step further and said that the ideas are universals in which particular objects in the external world partake.

It is rather difficult exactly to grasp the implication of Plato's idea or Aristotle's universal, and still more difficult to realize the essential difference between their two points of view. The great thing they had in common is that the idea or the universal, or what you will, is real, permanent and imperishable.

Although we speak of ourselves having a notion or a concept of the universal it cannot be described as a notion, because, as Plato himself says, if we allow that we have a notion or an idea, this idea must be an idea of something or of nothing. If of nothing, then the natural sciences, which all deal with properties of matter, must be concerned only with things which are imaginary. This is obviously nonsensical, for the whole fabric of our lives is based on the supposition that the objects of the natural sciences are real and that when we say that we have a concept of something, we do in fact have a concept of something real.

There are many modern philosophers who have argued that the universals or the ideas are only ideas of ours and have no existence apart from our conception of them. Plato and Aristotle, too, have won many supporters in modern times, and it is no exaggeration to say that the principal point of dispute between metaphysicians of all ages is precisely this: is reality to be discovered in the objectives of the senses or on the higher ground of realities apprehended by the mind?

Form and Matter

This, of course, was only one of Aristotle's contributions to philosophy, but in the development of his theory he is less easy to follow and less plausible. Like Locke, he distinguished between a kind of primary and secondary quality of which the former were substantive, such as humanity, and the latter consisted of attributes like colour and size. These latter, in his view, could be called real only because they were parts of the former. He distinguished sharply between form and matter. The form of a thing as an essential reality corresponds to Plato's idea, the matter is a realization of the form perceptible by the senses. The form of man, of course, is his soul, the matter his body.

Aristotle explained the duplication of form in species by a theory that in the world as we know it, matter is composed of the four

elements, fire, air, water and earth; whereas in the higher spheres of the universe matter is composed of a superior element which he called quintessence, imperishable and real, so that form and matter are united in one. Thus, to complete his philosophy, Aristotle presupposes what we should call another world —or heaven—in which everything has reached its highest state of development and is, therefore, changeless and eternal.

Immortality of the Soul

It is worth noting that for Plato life was inexplicable except on the assumption of the immortality of the soul, for which he set forth a theory of reincarnation. This theory in turn was the basis of his *Theory of Knowledge*, for it enabled him to give a rational explanation of intuition, or *a priori* knowledge, which we discussed in the previous chapter and which has been another point on which thinkers have failed to agree. On the basis of reincarnation, intuitive knowledge is a remembering of something learnt in a former life, while everything we learn from experience is laid up in the soul and will be used in some future incarnation.

We will now consider a single specific instance to show how theory necessarily affects practice. Justice will be the theme of this experiment, because the idea of justice is one which meets us at every turn of life. Justice, of course, is one of the universals and is representative of Plato's ideas. We can recognize a just man, a just law, or the execution of a just action, but we can never see, or feel, justice itself. We only have an idea or concept of it, but, as we have seen, the fact that we have this concept implies that it is a concept of something real, of the universal of which just men or just laws are particular instances.

Let us examine our idea of justice and see whether we can define from it the nature of justice exactly. This is where you, the individual reader, must come into the discussion, because it is you and every one like you who so readily attribute justice to the particular instances of it and who on occasion may well say: "All I want is just treatment."

Now, if just treatment is all you want you surely must know what you mean by it. How would you define it? How would you describe the idea or concept you have of it which you obviously expect others to have identically with yourself?

Is Justice Equality?

We will consider one or two of the possible answers you may give. One that is frequently given is that justice means equality, or, in other words, that justice is the regulating factor which should ensure that whatever there is to be distributed —whether it be material goods, such as food or drink or money, or intangible goods, such as pleasure —should be distributed in equal proportions.

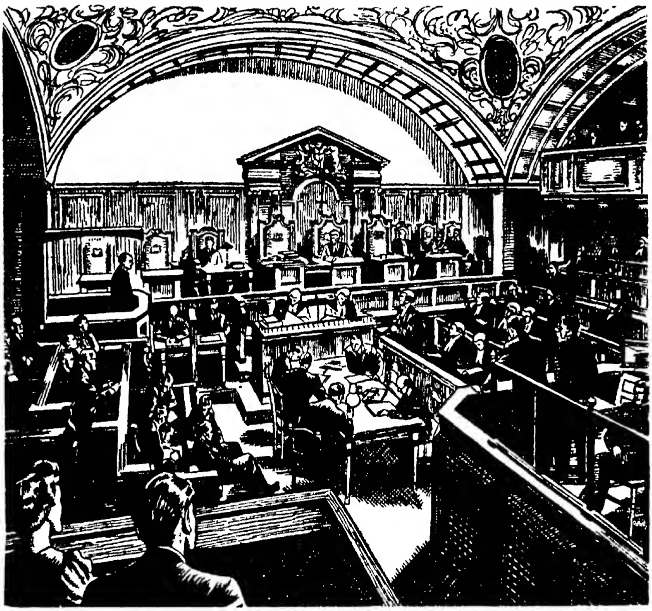
This is an explanation which has been very popular and arises, as

we saw in the last chapter, from the often stated supposition that all men are equal. We have seen most definitely, however, that all men are not equal, are not even born equal, and can never be equal, and we shall conclude with equal certainty that whatever the nature of justice may be it is certainly not equality. If it were, the principle of "the greatest happiness of the greatest number" would be quite meaningless, because it will often happen that if you have a given quantity of some goods to distribute, the principles of equality and the "greatest happiness of the greatest number" will be mutually incompatible.

Consider a simple instance. Suppose you were asked to reward justly the services of two people who had worked for you for the same time, one of whom had worked very hard and conscientiously and the other only slothfully

MEDIEVAL IDEA OF JUSTICE

The idea of justice has always existed in some form, though its interpretation has been widely different. In medieval times the method of determining guilt was trial by ordeal, and a woman accused of murder is pictured taking a red-hot bar from the fire. Absence of severe burns would prove her innocence.



A MODERN COURT OF JUSTICE

The application of justice in more enlightened times is trial by an impartial judge and a jury of twelve ordinary citizens. In this impression of a Criminal Court trial the judge is seen seated beneath the sword of justice, and the jury is on the left. The accused and warders are in the dock in the right foreground.

and with poor results. Would you reckon it just to reward them equally? Surely not.

We must alter our ground then and readjust our idea of just distribution and, in view of what we have just said, it might seem logical to assert that justice would be observed if distribution were according to work done. This is really the philosophical equivalent of the well-known theory of reward according to desert and, in the economic world, is equivalent to payment by piecework.

If a man contributes, it is said, so much to the common weal, then it is just that he should be rewarded correspondingly, so that if you have £100 to distribute between three people you will distribute it strictly in proportion to what they have contributed to make it available for distribution.

That is where we meet the first difficulty. The infirm may not be

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to equal consideration, and here we see the logical background for the widespread outcry against protected personnel, vested interests and other alleged evils.

Justice and Punishment

Justice is most often regarded as a matter of reward or punishment. If we say that justice always implies equality of consideration, we must conclude that men have a right to certain rewards for service, however difficult it may be to fix a precise standard for distribution.

Can we go further and say that punishments also are due to men, or to reverse the statement, that men have a right to inflict punishment on others as well as to reward them for their services? Any theory of punishment must take account of legal punishment because in modern societies the individual has largely abrogated his rights in this respect to the State.

The primitive idea of punishment, of course, is "an eye for an eye and a tooth for a tooth" and, historically, vengeance is much earlier than punishment. The desire for vengeance is certainly deeply rooted in human instincts and, in societies where a legal system is not fully organized, it is generally considered proper that a man should seek vengeance for wrongs done to him or to those connected by blood ties with him.

Modern opinion veers away from the idea of vengeance, regarding it as uncivilized. Some modern thought has tried to reconcile the two and has suggested subtly that in the idea of punishment, due allowance is made for the desire for vengeance, whilst in the primitive pursuit for vengeance there is always implicit the judgment that punishment is due. This seems an over-simplification of an idea which is constantly developing.

What then can modern thought put in the place of vengeance as the basis of punishment? The utilitarians have been very worried because crime causes pain and so does punishment. In their view two bads cannot possibly make a good, so that punishment in itself must be bad on the ground that things painful are always bad except as a means to greater pleasure.

Deterrent Theory

They incline, therefore, to what is known as the deterrent theory. Crime is punished, they say, in order to deter others from wrongdoing for the benefit of society. That is all very well as far as it goes, but if deterrence is the only purpose of punishment, it seems we ought to punish a man if he is thought guilty, even if we personally know that he is guiltless. The scapegoat immediately becomes a moral necessity; but that cannot be so, because we judge that only the guilty should suffer.

Punishment is reformative, another school of thought argues. It is our duty to win wrongdoers from their evil ways. If we admit that theory and take it to its logical conclusion, the habitual criminal

ought to go scot-free on the ground that he cannot be reformed, and punishment itself becomes no different from education, which, like punishment, is often both compulsory and painful.

Probably the truth lies in a combination of all three theories. The reformation of character is a work rightly undertaken by those charged with the duty of carrying out punishment by the State, but reformation is not the essence of punishment.

Seeing others punished no doubt deters wrongdoers from their plans and it is useful that they should be so deterred, but deterrence is not the essence of punishment.

Men do have a desire for vengeance which they express as a desire to see justice done, and vengeance no doubt enters into all punishment, but it is not the essence of it any more than the other two. Remorse is the punishment that fits the crime. The pains of remorse are the ideal and punishment stimulates them.

Nature of Truth

That is as near the truth as we can get on this vital point, but you may well ask with so much doubt on such important subjects: "What is the truth? What do we really know?" We will try to answer those questions, but the answers must be, in the nature of things, only tentative.

First we must distinguish between four shades of our mental state : opinion, belief, faith and knowledge. We may be said to hold an opinion when our observation and reasoning lead us toward a conclusion. We generally jump to that conclusion and say we know it, but if we reflect more deeply we shall find that we are not quite certain. You may draw a conclusion from the same data differing from the conclusion I draw. One of us may be right, or neither of us.

Belief may be defined as an opinion of the truth of which the individual is personally convinced. It may be either a matter of drawing a conclusion from available data, or it may be a matter of faith. For faith may be defined as the sum of beliefs for which proof is neither asked nor required.

Knowledge and Truth

Knowledge and truth are correlative. What I know is necessarily true, but what do I really know? I certainly know my own feelings and so does every one of us. I know that I feel hot or cold, and my feelings are therefore true, but what is there objective that I know?

Opinions differ on this point. Some think we know the truth of many things by intuition; others that our knowledge is derived only from experience, what we see, what we feel, and so on. Obviously there are many things which we know to be true for all practical purposes, even if we are not convinced that they are absolute truth. In that case we act on the assumption of their truth: on the assumption, for

instance, that the universe will not come to a sudden end; that a straight line is the shortest distance between two points; that pain is evil in itself; that all men are mortal.

Inference and Induction

We can extend this practical knowledge by two processes: by inference, which is the equivalent of putting two and two together to make four, and by induction. Induction is the process of stating a general rule from a number of observed particulars. All the members of the human race in the past have proved mortal, so I make an induction that human beings are mortal and that I and all my friends will die, and this I call knowledge.

Nevertheless it is not absolute, for there is the chance that I may be wrong. It used to be said that the proposition "All swans are white" was a true induction from the fact that a black swan had never been known. Since then black swans have been seen and classified, so the truth of that particular induction is seen to have been an illusion.

The theory of causality may be stated briefly thus: every event has a cause or causes which have determined it. As a law of the universe, this is probably the most important of all natural laws; it is the basis of all scientific and medical research, which is for ever seeking for a cause; and our whole reasoning processes are based on the assumption of its truth.

We need not delay to prove it, for it is one of those axioms which are undoubtedly true for all practical purposes yet cannot be demonstrated with complete finality. According to one school of thought, it is a self-evident proposition of the same kind as the statement that the shortest distance between two points is a straight line joining them, a condition as it were of our mental existence, and *a priori* in the strictest sense of the term.

According to another school of thought, the truth of the theory of causality can be known by induction. We have never had experience of an event which can be shown to have no cause whatsoever. More than that, the whole history of the human race fails to bring to light a single instance of such an event. Therefore, it is argued that the universal application of causality as a law of nature is a logical and logically justifiable induction.

Philosophy of History

One very interesting problem in philosophy arises from the acceptance of this theory, generally known as the philosophy of history.

This very general term includes a great deal which has been written in an effort to find universal truths applicable to the particular facts of history. More especially it is applied to the theory which, if stated in its simplest terms, amounts to the attempt to show that history repeats itself.

If we admit that history does repeat itself in broad principle, a number of important inferences

RISE AND FALL OF

The Roman Empire illustrates the stages which tend to repeat themselves in history. First a period of building and struggling to win a livelihood (1). Then a period of expansion by wars (2). When expansion is complete the

THE ROMAN EMPIRE

fruits of empire make hard work for all unnecessary, leading to degeneration and eventually decline (3). Finally, the empire is overrun by younger and more virile races, who are in the earlier stages of the cycle (4).

may be drawn. It should follow, for instance, that it is possible to forecast the future on the basis of the past with some degree of certainty; and this possibility is so outstandingly important that we ought to examine it with particular care.

First of all, we must ask ourselves: Does history in fact repeat itself? in other words, is there any evidence from experience to support the assumption? Secondly, we must discover the logical background for the statement; and thirdly, consider, by way of criticism, some consequences of accepting the view. If these consequences are quite unacceptable we shall be justified in rejecting the assumption. Those three steps are always a sound way of testing the truth of any doubtful proposition and have aptly been named as the minimum basis of logical method in the approach to truth.

Does History repeat itself ?

First, then: is there any evidence from accumulated experience to support the simple statement that history repeats itself? We must admit that in broad outline there is. One instance, or rather one series of instances, will serve to make the matter clearer.

Consider the history of any number of representative empires in the world. Take, for example, the Roman Empire from ancient history, the French Empire from later medieval history, and the civilization of neolithic man as evidenced by field research in Britain from pre-history. These are three widely differing periods about which a great deal is known. The most cursory examination will show that the history of each can be summed up in very much the same way.

There is first a period of hard struggle during which the winning of a bare livelihood absorbs all the energies of the citizens. This is a period of stern moral codes and comparative insensitivity, in which the more refined aspects of civilization as we know it—art, music, literature and so on—are conspicuously absent.

Period of Expansion

It is followed immediately by a period of rapid expansion built up on the fruits of the preceding period of hard, even harsh, labour. This expansion is sometimes by force of arms, but sometimes also by what is known today as peaceful infiltration. The winning of fresh lands inspires an unsophisticated art and literature, but the general tendency is still toward stern living under hard discipline. Men must be relatively insensitive in order to approach their warlike tasks with eagerness. "War is the father of men" represents the philosophy of these periods of history.

Once the expansion is complete a change sets in. The fruits of empire make hard work on the part of any and every citizen unnecessary. A wealthy class arises and there is an increasing disparity between rich and poor. The enthu-

siasm of the individual citizen diminishes and there is discontent at the manifest contrasts in standards of living. With the comfortable philosophies of the "haves" and the discontents of the "have-nots" the spur to greater and greater effort has gone.

Nevertheless the wealthy become patrons of the arts and a prodigious output of art, music, and literature results. Moral laxness and greater striving after individual expression are other signs of the times.

Decline of an Empire

Inevitably, it is said, a decline sets in and the civilization represented by that particular empire ultimately falls to the ground. Either it ceases to be important, or it is overrun by a new and vigorous people in the first stage of this development, maturity and decline.

Of course, some of these stages are lacking from the history of many civilizations. Not all of them are present in the case of two of our examples—the French Empire and the neolithic civilization—but the salient features are more or less identical and they are true, too, in more or less exact detail of the ancient Greek civilization, the Chinese Empire, the Inca culture of Peru, the ancient civilization of Egypt, and some of the nations of Europe which emerged from the break-up of the Roman Empire.

It is not only in general trends that support has been found for this phase of the philosophy of history. It has often been urged that history repeats itself in different countries at different times, even in the sequence of actual events.

Religious History

A single instance or comparison will make this clear. The religion of ancient Egypt was a polytheistic one, that is to say, it embraced very many gods. In the fourteenth century B.C., Amenhotep IV (later Akhnaton) tried to change the religious outlook of the people.

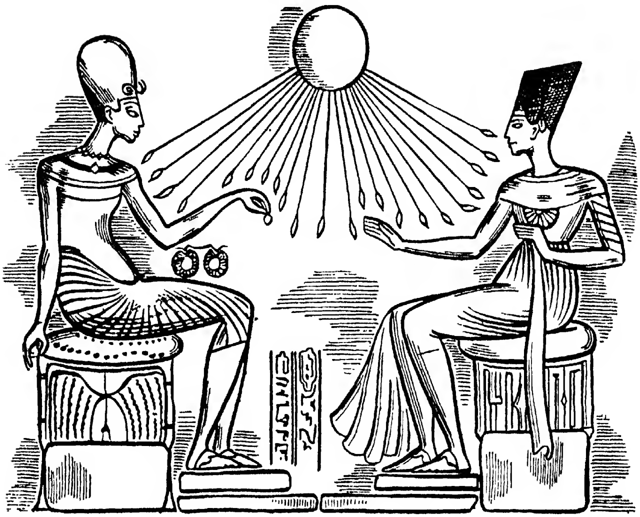
He succeeded in making the worship of Aton, the sun god, paramount in the country, yet when he died the Egyptians reverted to their traditional religion and damned Amenhotep as a heretic. Yet two thousand years later Egypt embraced monotheism as surely as the rest of the civilized world.

In just the same way, in Britain Christianity was introduced from Rome about the beginning of the fourth century A.D. and Christian churches were built in the Roman towns. A hundred years later Christianity had been swept away and barbarians were in possession of the civilized towns of Britain.

Yet two centuries later, just as Egypt adopted monotheism, so Britain again embraced the Christian faith, following the conversion of Ethelbert by St. Augustine.

The second question is: what is the logical background for the theory? It is that if every event has a cause it may be argued that similar events have similar causes.

If we had sufficient knowledge and wisdom we should be able to



KING WHO ESTABLISHED A NEW RELIGION

Over 3,000 years ago an Egyptian king, Amenhotep IV, abolished polytheism in Egypt and established the cult of Aton, the sun god. Although he was successful, all trace of his work was obliterated after his death. Here he is shown with his wife, Nefertiti, worshipping Aton, represented by the solar disk.

discover all the causes which produce a given event, and if we recognize a given series of events which have been followed by another series of events, we can say that these events are the causes of the events which follow and will again be followed necessarily by a similar series of consequences.

Therefore, once we have recognized a series of causes as such, we can forecast the future with every prospect of success.

Thirdly: what are the consequences of accepting the view? The one we will consider first is one which has had a most deplorable effect on a limited number of citizens of the British Empire.

Some writers and speakers have claimed that the progress of British civilization and culture has closely followed the cycle of development and maturity which we have noted above. They infer that it is now approaching its decline and that nothing that any one can do will alter the progress of events, since similar events necessarily follow similar causes.

This is manifestly a very dangerous view to accept, because acceptance of it, by making men and women believe that the decline is

inevitable, is bound to encourage them to give up a hopeless struggle and so help the very sequence of events which they regard as inescapable.

How then shall we refute it? We shall do so with some confidence. The application of the theory of causation to this particular problem is accurate enough as far as it goes; but it ignores completely one factor which must surely be weighed in the balance. That is human freedom or free will.

We considered the problem of freedom most carefully in the last chapter and we reached the conclusion that man has got an ultimate freedom of choice to act in accordance with his moral judgment. Since history is man-made, it must follow that this freedom has its part in making history.

Man's Freedom of Action

If we accepted a mechanical view of human action we should have to admit the proposition we are disputing. But, as we have seen, we are not automatic and human activity cannot be explained except by reference to the concept of freedom. Since, then, man is free absolutely to act as he wills and his will in the future is determined always by an individual act of judgment, it must follow that the actions of mankind are, strictly speaking, unpredictable. Consequently, the future course of events as determined by human action is also unpredictable.

We may admit that history tends to repeat itself because man often wills similar actions in similar circumstances—the history of creatures without free will certainly would repeat itself—but there is nothing inevitable about the future. We might sum up by saying that it all depends on mankind itself, and since it is a fact that man has evolved and still tends to develop, we might conclude that there is a strong probability that history will not go on repeating itself.

Theory and Practice

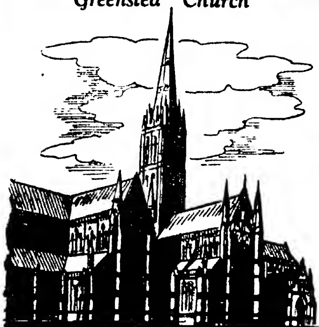
We have deliberately ended this brief review of some problems raised by philosophy with one which closely touches the affairs of the ordinary man and woman. As the level of everyday thought rises and as education brings the possibility of constructive thinking to more and more people, the relation between theory and practice tends to be closer.

Among many facts elucidated by philosophy which are important in everyday life is the dual role in the human make-up of reason and feeling. So far as we are feeling creatures, we are affected by the emotions; it is the function of reason to exercise judgment on these emotions and to regulate them for the good of humanity, not necessarily to subdue them.

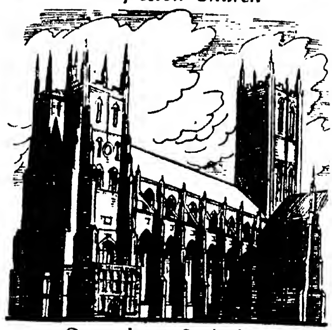
Once we have realized the relation between opinion, belief and knowledge (or truth), and between deduction and induction, we are nearer to an understanding of ourselves and of the foundations of knowledge, man's true inheritance.

Greensted Church

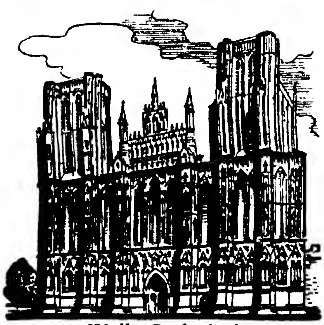
Barfreston Church



Salisbury Cathedral



Canterbury Cathedral



Wells Cathedral

St. Paul's Cathedral

ENGLISH CHURCHES THROUGH THE AGES

Many of the world's most beautiful buildings have been raised by man to the glory of God. Here are some representative types: Greensted (Saxon), Barfreston (Norman), Salisbury (13th century), Canterbury (14th and 15th centuries), Wells, West Front (14th century), St. Paul's (17th century).

CHAPTER EIGHTEEN

SPIRITUAL MAN

Universality of religion. Contemplative and practical sides. Spiritual experience. Two great commandments of Christianity. Science and religion. Immortality of the spirit. Hinduism and its teachings. Rise of Buddhism The religions of Japan and China. Zoroastrianism. Muhammed and Islam Development of Judaism. Teachings of Christ. Future of Christianity

MAN, it is said, is incurably religious. His religions indeed have been many and diverse, but nearly always they have made him look beyond himself to a Power which is not himself. Wordsworth said, "I have felt a Presence that disturbs me." But so also have the Australian aborigines and the Indians of Patagonia. "Has anybody taught you about God?" asked a missionary, when he came to a very primitive tribe. "No," the chief answered, "we do not know the name, but we do know One who walks among the treetops in the cool of the day."

Man's Need of Religion

Go where you will in this great world, north, south, east or west; dig deep into the sands that have buried ancient civilizations; read the hieroglyphs graven in stone or the ancient Vedas of India, and you will find yourself confronted always with some kind of religion. He would be a bold man, most recklessly bold, who would dare to assert in the face of all such human experience that the whole of it has been illusion—that there is no insistent reality behind it, "nothing there."

But what is religion? Studdert Kennedy spoke out plainly on that point. "A man's God is what he lives for." That surely is true. A religion that makes no difference to a man's life can hardly be called a religion. It is nothing more than an unthinking nominal assent to a theory in which he is not interested.

Worship of Other Gods

In what, then, is he interested—to the extent of giving his life for it, spending his youth for it, scorning delights and living laborious days?

Obviously there are many answers. Money—the golden idol—is certainly one. Power is another, and the lust for it is the curse of this age, as well as of many an individual life. Fame is another, and so is Happiness. Here is the beginning of a modern Pantheon. "These be thy gods, O Israel." To these we offer the covetous worship of our inmost souls. To these, also, we sometimes offer our homes and our little children. It may sicken us to think of human sacrifice, of infants handed through the fire to

a grinning Moloch, but we are doing that sort of thing still, in our more civilized and perhaps more devilish way.

It is not for us modern folk to despise idolmakers. We ourselves belong to that ancient craft. And it may be that "the heathen in his blindness," bowing down to wood or stone, is a bit more honest than we are. We do that same bowing down, though we have become very angry about images, but at the same time, at least on certain occasions in the year, we profess to be Christians. That is why the heathen would seem to be the more honest. Crude as their ideas of God may be, they do avoid at any rate the lie in the soul.

Beginning of Religion

Of course, Studdert Kennedy's definition, though it cuts very deep, is not a complete one. There are some who would look first for a sense of the Unseen; for an "awareness" of a world beyond our seeing; for an inward awe or hush of the soul which, at any moment or in any place, may betoken the Presence of which Wordsworth wrote.

Hinduism, for example, in its earliest beginnings, looked out upon the world in such a childlike wonder that it could only believe that everything everywhere was full of the life of God, although God Himself was thought of as unknowable. The next step is plain. If God is unknowable, then it is man's wisdom—and safety—to worship those things in Nature which, by their mystery or majesty, their power to give life or to destroy it, are much to be wondered at and most certainly to be appeased.

Search for the Supreme Being

It is all very simple and childlike. Religion cannot begin with the Thirty-nine Articles, nor is it likely to end there! It is all a search for God, for the Great Spirit, for the Supreme Being, however inadequate may be those first ideas of Him. And it all begins in wonder. "He who wonders shall reign, and he who reigns shall rest." From the beginning religion is a response to something which strikes him with awe, to something which in such early days probably makes him afraid. The great point is that at such times man is "aware" of the Unknown. That "awareness," as mysterious in the Christian mystic as in the primitive savage, is the birth of personal religion.

There are thus two sides to religion, from the first days until now—the contemplative side, in which man looks upward toward God as the source of all strength, all inspiration, all blessing; and the practical side, in which man seeks to use that strength and inspiration in ways that will please God and do good to his fellow men. Obviously these two sides correspond roughly to two opposite temperaments.

The "practical man" often admits—and even boasts—that he has no time for prayer. The devout man, on the contrary, is apt to be content with his rapt devotion and to be of

little use to others. Martha and Mary in the Gospel story are exact pictures of these two types. But neither of them is a picture of religion at its fullest and best. Mary, Christ said, had "chosen the better part," though she was not very good at getting things done. Martha was so busy that her whole mind was full of busyness. She was always at work, without pausing to get more strength for that work. She was always giving out without taking in. Such souls are the salt of the earth in any generation, but they do get exhausted sometimes, fussy, fretful, irritable. They do miss a lot too, and find continually that their work has been in vain. In our own age we respect above all things "the man who gets things done." Yet what has come out of it? It would have been better for all these practical people to have paused awhile; to have found enough quiet to possess their souls; perhaps even to have waited for a vision of what was really worth their doing. That, in general, has been our experience over here in the West.

Religion in the East

The East is quite different. Religion there is mainly contemplation. "Be still, and know that I am God." Where in the West could we find any man in the least bit like Buddha under the Bo-tree, thinking, thinking, thinking about the mystery of life—and the way out? Of course we have had our own mystics, and their lives also were given wholly to prayer and meditation. But the East can show its millions who try deliberately to follow the way of Buddha—in contemplation—whereas in the West we must be content with some thousands at the most. Speaking generally (which, of course, is a dangerous thing to do, and only to be attempted in order to give a rough idea of the contrast), we in the West have "got things done" at the cost of almost losing the thought of God altogether. On the other hand the East is much more "aware" of the Unseen than we are, much more powerful in spiritual faculties, but definitely backward in practical results. The complaint of the East is not that we are Christians, but that we are such bad and lukewarm Christians.

Apathy of Christians

An Indian visiting this country some years ago told a meeting this: "If I could believe what all you Christian people say that you believe about Christ, there is nothing that I would not do or dare or suffer for His sake; yet, when I look at you, how tame and insipid you all are."

Both sides of religion must be seen and accepted, if religion is ever to be what it might be. Prayer, devotion, contemplation, worship—these are the deep springs that bring vitality and refreshment to a man's life. Without them he is left with a sort of Humanism, which is an impious attempt to do God's will without God. He bows God

out of his life, because he is quite capable of looking after himself! And that is not only a common error in individual lives. It is the primary danger that confronts our badly shaken civilization.

Vision and Reality

On the other side, work and service to humanity find their only true motive in communion with God, and take their only real strength from the power that He gives.

In the story of the Transfiguration (depicted with such a moving challenge in Raphael's great picture) we meet the problem again. The three Apostles who saw on the Mount the Transfigured Christ, asked to remain there indefinitely, quite unmindful of the pathetic crowds awaiting the healing touch in the hot plains below. The rest of the Apostles who had remained down in the plains, were confronted with a devil (in a tortured child) which they could not cast out, because the power was not in them. There are the two main mistakes of the life of religion—either to seek the Mount and stay there, or to be so anxious to do practical things that there is no chance of seeking the Mount at all. The judgment of Christ is clear. There were two great Commandments, He said, summing up all the rest. The first was to love God wholeheartedly; the second, "like unto the first," was to love one's neighbour as oneself. We shall never get a true and virile Christianity until we learn to keep these two commandments, and in that order.

In all that has been said so far, it has been assumed that the basis of religion is a definite spiritual experience. Almost all of the great religions take their authority from such an experience in the life of an outstanding personality and saint. That experience to the Leader himself was absolutely valid and convincing. There could be no explanation of it but the fact that in his life there had been an "invasion" of the Unseen. Powers not of this world had broken through upon him. The very heavens were opened, as they were to St. John at Patmos, while he was "in the spirit on the Lord's Day." But the experience was not limited to the Leader (except perhaps in the religion of early China). It was felt at times and in various degrees by all his followers. Can any honest thinker disregard this vast body of spiritual experience, proved in its sincerity by the lives and sacrifices of great multitudes of every age and race? And is not this same experience the only firm basis of anything that is worth calling a religion at all?

Sudden Conversion

When a man says that he has "found God," we may not like the phrase that he uses and we may be very sceptical about what we may call some emotional crisis that has happened to him in a moment of high tension. Yet if from that moment his whole outlook upon

life is changed, together with his way of dealing with it, have we any right to doubt that something really has happened to him? St. Paul on the Damascus Road is only one of millions who have seen a light more dazzling than the sun and heard a commanding voice. From that time on St. Paul was a changed man. So have most of the others been—changed men. It is in that practical evidence, which surely ought to appeal to "practical men," that religion is vindicated.

If such experiences are mere illusions, most strangely repeated at all times in all circumstances and in all places, all down the long and chequered history of mankind, then the more illusions the better. Let us be quite clear about that. Scientific achievement, which demands scientific tests and methods in every sphere of life, has, on the whole, a very poor moral record behind it. It cannot suggest a meaning for life. It cannot produce an adequate motive for right living. And its own easy perversion to the most monstrous ends very far exceeds the lamentable inconsistencies of religious converts. In any case the experience goes on. For all his science man remains to this hour "incurably religious."

Nevertheless, the challenge of science is one that must be taken seriously. For, though very few really great scientists are prepared nowadays to continue their attacks upon religion—and a large number of them are sincere believers—yet public opinion lags far behind.

HEAD OF CHRIST

This representation of Christ, found in the catacombs of Rome, is one of the earliest known. It is probably based on contemporary descriptions.

Probably the majority of people still feel that religion and science are at loggerheads, and that religion can only survive by hiding its eyes from proved scientific discoveries and facts. This is a serious matter in an age which worships science and looks to science for human betterment, although the war was a very rude awakening for many.

Look straight at the facts. Is science able to give a full and satisfying account of man? The days have gone by, of course, when any scientist would claim to be able to analyse a human body, separating

out in their exact and various proportions its contents of phosphorus, carbon, calcium, iron, water, and the rest, arranging them in labelled bottles on a laboratory shelf, and declaiming—"Behold, the man." That was always childish because, as the East has reminded us for thousands of years, there is more in man than his physical body. Moreover, any group of quite ordinary people, watching the death of a friend, stumbles spontaneously upon the truth. "He is gone," they say and very truly. For that rigid body, however you may analyse it, is definitely not the man that they knew.

Soul of Man

The days have also gone by when any scientist would protest in a very superior manner that he had explored every region of the human body and had never found a soul —not even "the God-shaped blank" confessed by H. G. Wells! Who on earth ever supposed that the soul is part of the physical body? Even in early Judaism (as we can read for ourselves in the more ancient books of the Old Testament) "soul" is regarded and described as "breath." That was the word that the Jews had for it. Their thought was not of anything material at all, but of an invisible force, entering the physical body, inspiring it, controlling it, and imparting to it the principle of life. No soul—no life: that was their contention, expressed in those very unscientific ages, through the most amazingly beautiful folk lore and parables. It is our contention now.

Certain scientists are most anxious to explain it away. We find ourselves discussing glands and other physical conditions, which quite clearly do work toward changes in human personality and character. But in considering the behaviour of the body, we must consider the behaviour of the ordinary man, not the abnormal. Diseases of mind or body, however potent to disturb the balance of our thinking, can never disprove the existence and the desirability of normal health. This is a problem which further research will elucidate as time goes on, as other similar problems have been easily explained before. It does not do to jump to conclusions, to condemn religion on the strength of a mere hypothesis. The truth is never the enemy of truth.

Churches' Attitude to Science

On that point the Churches need a great deal more courage. For—to be honest again—the Churches all down the centuries have tended to take panic at new scientific knowledge, to condemn it out of hand, and often to persecute it at the stake. That most stupid and unchristian attitude has been generally followed by an attempt at compromise, as, for example, when it was pretended that the Book of Genesis was really in exact line with Darwinism. There was no need of any such compromise, though a discussion of that point must be left to pages that come later. The

whole controversy was very regrettable. Let truth speak. It will never contradict man's inmost and invariable experience. But scientists are far too quick to proclaim their latest discoveries as the truth, the whole truth, and nothing but the truth. In that history has proved them wrong over and over again. There is nothing that changes so quickly as scientific opinion! So it ought, for truth is greater by far than our self-confident little minds.

Churches and Tradition

On the other hand, the Churches are far too anxious to preserve their traditions, even when their traditions are so outworn as to make the Word of God of none effect. That is the position now, except for the significant fact that so many distinguished scientists do most readily allow for the essential truth of religion. It is hard to understand why the others wish to disprove it.

After all, it would be the most amazing thing if those ten green bottles, carefully arranged along a laboratory wall, were to conspire together and protest that there was nothing in them (or in the human body from which they came) but their labelled contents! It is the scientist himself who needs explaining. If he too is only a complicated chemical compound, who is he to judge in so great a matter? From all such misunderstandings as these a sense of humour might well save us—as well as a little philosophy.

In these days it is customary to speak of man in the various aspects of his life. Rational man, for instance, represents him as a creation of reason and intelligence—homo sapiens. Sociological man presents him as a member of a herd—as he deals with his neighbours, singly or in very large groups. Psychological man explains, so far as at this stage they can be explained, his pattern of behaviour and the mental processes which form that pattern. Economic man depicts him in regard to his work, his wages or other means of livelihood. All these are aspects of man, considered from different points of view. They cannot be separated. But spiritual man is the real essential man, not one aspect of him, certainly not one department of his life. It is the contention of this section in this book that man is by nature spiritual, indeed that he is an immortal spirit, tabernacled for a time in this wonderful house of the body, but akin nevertheless to other spiritual personalities, whether in this body or not. Ultimately he must move out of his house, grown old and beyond repair. What then? Why, then in the fulness of his personality, his faculties of mind and heart unimpaired, he goes out and on to a wider and higher state of being. That is his inevitable destiny.

Unity of Body, Mind and Spirit

While man remains in this body he must be considered as a whole. What we call human nature is a unity—of body, mind and spirit. It is a fundamental error to attempt

to treat one without the other. Disease of mind produces at once bodily effects. Indeed there are those who believe that all bodily ills have their beginning in a disordered mind. For that reason they look for a revolution—though not yet—in medicine and surgery. Every diagnosis must cover the mental condition as well as the physical condition, and every cure must be a cure of the mind, not less than the cure of the body which has expressed in its own way a deep-seated mental unrest. We must beware therefore of thinking of man in departments. He can never be known nor understood except as a whole.

On the other hand man is so much more than his physical body that he can live without it. That is what happens at death, though he finds then for his use a body of spirit appropriate to his developing destiny and environment. "There is a natural body, and there is a spiritual body," writes St. Paul.

Problem of Death

It is well that we should make every effort to understand this, though here there is no space to do more than to touch upon it. All down the centuries man has been perplexed about the problem of death, often terrified. There are two ideas which haunt many people today, especially in time of bereavement. One is the impossibility of imagining bodiless spirits, and the other is the burial of a person with his physical body in a grave. Both of these ideas are the result of wrong thinking. No man is ever buried at all. It is only his mortal part that is put reverently away like an overcoat that he once wore. No man after death finds himself an airy spirit without a body. No man is unrecognizable after death to the eyes of those who also have come to share his state of life. And no man, having passed out of his physical body and passed on into the unknown and the unseen, is thereby separated from those whom he has loved and (as we too often suppose) left behind.

Unchanging Spirit

These are points of supreme importance to any who would understand the Christian religion, taking to themselves both its comfort and its startling challenge. Immortality is no small matter to any one who thinks about it. The East, which has always had its own ideas of the life after death, has taken it with a profound seriousness. In the West we think about it very rarely, and then only when something happens.

Our great mistake is to consider this question of the physical body as a theory to be settled by argument. It is nothing of the kind. We know well enough that a man's body changes almost entirely every seven years. Any child realizes that the body of his babyhood is very different from the body of his manhood. Day by day this body of ours is in a state of flux—something being discarded as dangerous or

CHRISTIANITY COMES TO ENGLAND

St. Augustine was sent to England by Pope Gregory I in 596 to convert the island to Christianity. He landed in Kent and began his work there. He converted King Ethelbert, and founded the archbishopric of Canterbury.

worn out, something being repaired, something being added. Yet we ourselves, with our memories of childhood and youth, middle age and old age, remain ourselves. We change too, but the core of personality and the essential spirit that maintains personality know themselves to be the same. Why then should it trouble us if, in the order of nature, there comes a time—as it must come—when, not in slow gradualness, but in the twinkling of an eye, we leave a body behind that we may pass on to the next stage of the unbroken eternal life?

It has been stated above that body and mind are interdependent. So they are, but how very greatly is the mind the predominant partner, especially in our later years! The body grows frail and old, but within it is a spirit more radiant than ever. Youth looks out of old tired eyes. Plainly the man himself is very much alive, more so than ever. His personality also has been very greatly enriched since he was a boy. But to say, with Horace Walpole, that "experience comes at the wrong end of life, when we can make no use of it" is an utterly wrong interpretation. When the body has become a burden (Plato called it a tomb), the personality soon goes on, to use its faculties in

a higher sphere of being, according to the quality of its character, without let or hindrance.

The study of great personalities leads us to the same definite conclusion. How many great men have had poor bodies, ailing bodies, sometimes even malformed bodies! Judged by physical standards many of them were quite subnormal, lower than the military C3. But through that physical infirmity—or possibly because of it—there shone greatness, power, artistry, leadership. It is no uncommon thing for a great man or a great woman to limp through life. In thinking of them, therefore, we come again upon the truth that Spiritual man uses his body. It is not a question, as the Behaviourist psychologists maintain, of the body using him.

Immortality of Man

So, without any appeal at all to the Christian Gospel (which is decisive) our immortality seems to be a truth that we live and learn, if we have our wits about us. As the curve of our physical strength goes down, the curve of our vital personality goes up. That is often an exasperation to old folk. It would be a mighty hope for them if they thought more deeply about it. Get it clear, then. A man is not a body possibly containing a soul (or spirit): he is a spirit possessing and controlling a body. And if the body should fail him his soul goes marching on.

Now, having said that much about the spiritual nature of man, we might do well to pass in swift review some of the eleven living religions of the world. There could be no more fascinating study, and, among other things it will help us to understand better and to interpret more fully and deeply our own Christianity. It is very definitely from the Christian standpoint, of course, that these pages are being written.

Hinduism and its Beliefs

The oldest living organized religion is Hinduism, which dates back to 1500 B.C.—perhaps earlier. Its present number of adherents—in India, Ceylon, Thailand, and South Africa—must be somewhere between 250 and 300 millions, divided up into a great number of sects. It seems probable that this vast number will tend to decrease rather than increase.

In Hinduism, as in other religions, there have been various stages of thought and development. There has also been a sort of dual teaching, one for the initiate—the superior person of understanding—and another for the simple peasant. The deep philosophy of Hinduism is, of course, beyond the peasant mind, as will be evident when we examine it.

The stages of development were these. In the earliest days there was little more than Nature worship, which is only to be expected in a land where more than 85 per cent of the population still lives in country villages. To these simple souls the natural world was full of

wonder. More than that—it was full of living wonder. The sun, the moon, the wind, the storm, the fire, were Beings, Gods as we should call them, whose help was to be supplicated and whose wrath appeased. It was a homely, childlike religion with nothing much in the nature of morals attached to it. The gods themselves were immoral. Indra was genial, kindly, but generally drunk. Agni was the sacrificial fire, Soma the sacred drink, and Yama, the first man, the ruler of the dead. It is very interesting to note that in those far-off days the Hindus had a belief in immortality, though in later times immortality was regarded as more of a curse than a blessing. Yet in the early *Rigveda* we find the hope to be "immortal in the realm of eager wish and strong desire, the region of the radiant moon, where food and full delight are found." In that realm, as Dr. Cave describes it, "Heaven was conceived, not as a dim realm of disembodied spirits, but as a place of light where the spirits receive bodies in which they may enjoy more fully joys like those of earth."

Primitive Ideas

It was a very material heaven, this, with no trace of any growth in character, and it is in absolute contradiction to the teaching of later Hinduism. It is extremely important to note that in all religions there must be this slow development. Only from "dim beginnings" do they move across the centuries "out to the undiscovered ends."

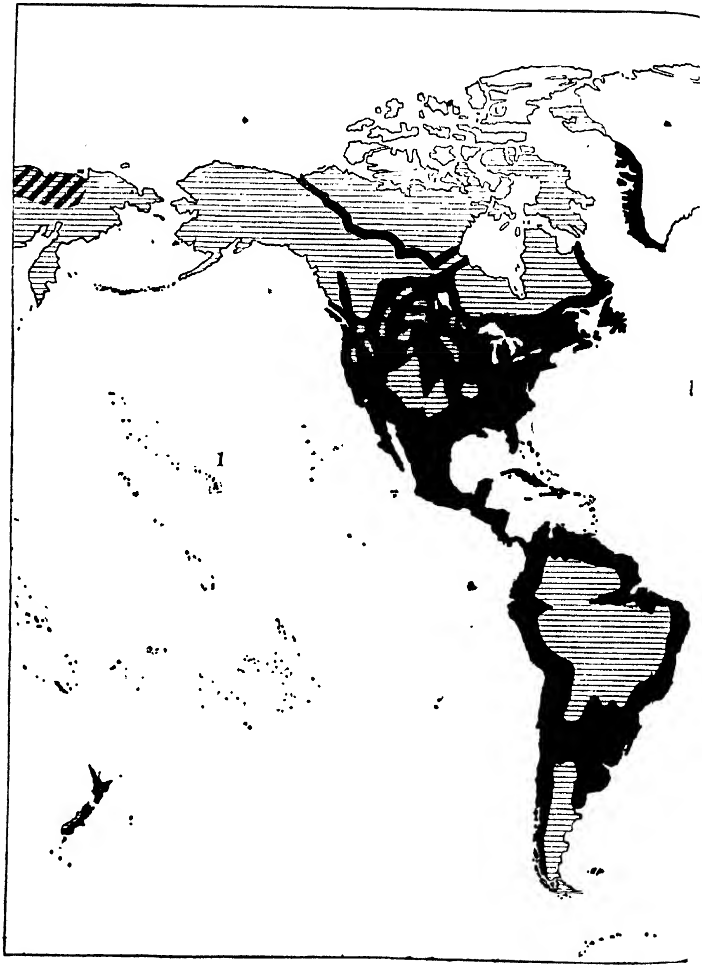
This is true, of course, of Christianity, but it is a truth only very partially grasped by Christian people, who often resent it. Here at least is one cause of the present religious indifference in the West. Science has challenged the early books of the Old Testament. It would all look very different if we would realize that early books are early books. Education must depend always upon how much a child or a primitive tribe can "take in."

Plurality of Gods

In the *Rigveda* prayer is made to some seventy-six gods and goddesses, of whom Varuna, the Encompassing Heaven, was the highest. In the hymns to Varuna—some of them very beautiful—there is a prayer for escape from sin, but sin, as we interpret it, was never felt as guilt. It was the consequences that these simple folk sought to escape.

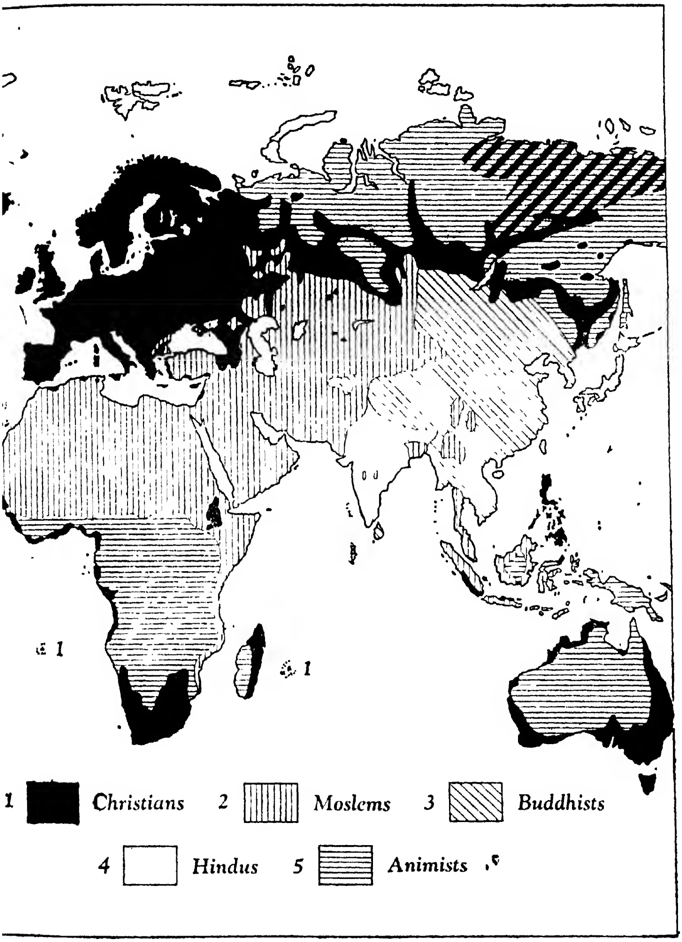
After 200 years of the Brahmanas—a time of sacerdotal and ritual domination, with its usual moral decadence—there came the Upanishads (600 to 500 B.C.), which set forth the inner philosophy of Hinduism. It is not so easy to understand.

Brahma (a word that formerly meant prayer) is now declared to be the Supreme and Absolute Being, eternal, omnipresent, but impersonal. The Hindus have never believed in One God, who in



DISTRIBUTION OF THE PRINCIPAL

This map shows the distribution of the five main religions of the world. It can, of course, be only a general guide, since it cannot deal with minorities, or with less important religions. In China, for example, many millions follow the teachings of Confucius, while in Japan Shinto has many adherents.



RELIGIONS OF THE WORLD

Animists (worshippers of many gods or spirits) are for the most part primitive peoples in sparsely populated areas, such as Central Australia, the Amazon forests of South America, and the north of Canada. There are, however, Christian outposts in these regions and in most parts of the world.

himself had all the qualities of heart and mind that we call personal. They could not conceive of a God who cared. Therefore, in the words of a modern Hindu author: "The Hindu is fundamentally an agnostic."

Man himself, always closely interwoven with all other living things, had in him a divine spark. It might be more accurate to describe him as an "emanation" of the impersonal Brahma, and his final destiny a reabsorption into Brahma. This indwelling Brahma they called Atman, though neither Brahma nor Atman could be fully known or described. "It is not this, it is not that." One of the Upanishads says: "The Atman in man is the very same as the vital force in the elephant, the gnat, the ant, the four quarters of the world." This sense of interwovenness has many consequences in Hindu religion.

Hindu Idea of Salvation

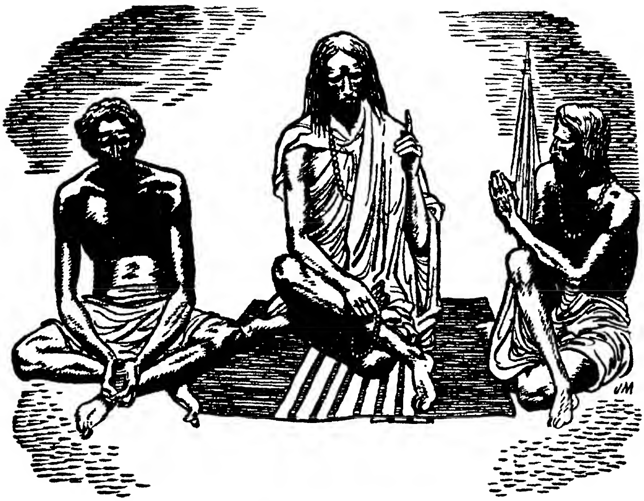
The world outside was merely *Maya* (illusion) and salvation (as the Hindu desired it) was by contemplation of the self and its union with Brahma, attempted at times by the inducement of a state of trance.

At about the year A.D. 1 we have the Bhagavad Gita, in which Krishna (declared now to be derived from Varuna and to be the Supreme God) offered salvation to all men, even to women and low-caste Sudras. Krishna became incarnate. He is said to have insisted firmly on the caste system, explaining it in terms of a living body with its various members, all needing each other. The Brahmins were the head, the warriors the arms, the tradesmen and farmers the trunk, and servants the feet. This fundamental law of caste persists, of course, today. If it ever disappears in any wider idea of the essential brotherhood of man, Hinduism will disappear with it.

Karma and Reincarnation

At this same period the doctrines of Karma (deeds) and of reincarnation impressed themselves upon every devout Hindu. Later Hinduism (the *Epics* and *Puranas*) reintroduced the old gods in newer forms—Vishnu, the Creator, utterly indifferent to man, periodically incarnate on the earth; Siva, the Destroyer; and many others, including Kali, the black and revolting goddess of death. Of all these, idols were made in grotesque forms. Pilgrimages to sacred shrines and rivers were undertaken as ways of acquiring merit. Yet there was no moral life to be considered, except the breaking of the very strict caste rules. For the higher castes vegetarianism was prescribed and total abstinence from alcoholic drink. From all of it—temple worship and social intercourse alike—the lowest caste, the "untouchables" were firmly excluded.

Regarded as a whole, Hinduism is a negative religion. It says "No" to life. "To be or not to be" is never the question. "This life holds nothing for us." To get out of it, to avoid the weary succession of



HINDU HOLY MEN

Hindus believe that only by prayer and fasting can they achieve oneness with the Absolute. The Yogi, or holy men, therefore spend their lives in prayer and meditation, sitting for hours in a certain posture, as shown above. Frequently this physical posturing will result in a withered arm or leg.

rebirths and the inevitable spiral of reincarnation, is the great aim. "Not life, but life's cessation," as Dr. Cave puts it, "seemed the highest good within man's reach."

The difficulty of course was Karma, the carrying over into the next life of penalties incurred in this. Nobody has ever been more sure than the Hindu of the essential law of sowing and reaping. "He who plants mangoes, shall eat mangoes; whoso plants thorns, thorns shall wound his feet." Therefore every new incarnation begins with an account rendered. The evil had to be worked out of a man, either by contemplation ending in the purging of all desire, or by works of goodness, though these in any case could only take him part of the way. No thought of divine forgiveness ever comes in. How could it, when the Deity was conceived as quite impersonal and indifferent? Man was left to work out his own salvation, and that salvation was nothing but an ending to a very weary journey—a Nirvana of something like dreamless sleep.

We have to remember, of course, that the individual as such counted for little or nothing. He was part of a whole, nothing more. In

himself he had no worth and no rights. Spiritually Hinduism is what we might call a totalitarian religion. It has always been a religion of fear—manifested in hideous forms in the popular worship of Kali—and, so far as man is concerned, it can only bid him flee from life and undergo a hundred rules and regulations that seem to offer a way of escape.

How contrary this is to Christianity, which, though in various ages it has tended to a puritanical and negative distrust of life, is really the religion of a more abundant life, both here and hereafter! "I am come," Christ said, "that they might have life, and that they might have it more abundantly."

Consequences of Sin

The doctrine of reincarnation —not found in early Hinduism—follows naturally from the Hindu conception of Karma. We Christians know well enough that sin has its inescapable consequences. It was St. Paul who declaimed, "Be not deceived. God is not mocked. Whatsoever a man soweth that shall he also reap."

But St. Paul had a firm faith in a life after death beyond this present material world. The Hindu has not. Therefore the Hindus had to assume another life here, and since that next life, beginning with a moral debt, would almost certainly accumulate a bigger debt, he had to face the probability of a long series of lives before he could be free. To have done with it all was his deepest wish—a nihilist view of life.

"The law of Karma," writes Mr. Richard Ince, "is said to act and react like the swing of a pendulum. Thus (crudely expressed) A murders B; in their next lives B kills A; in the following life A kills B again. This continues until A or B kills that in himself which caused him to kill the other. The law then becomes modified."

Divine Forgiveness

What is wanting is a doctrine of divine forgiveness, as proclaimed by Jesus Christ. Yet, be it noted, Plato taught this doctrine, so firmly held in the East. His order of progression in the *Timaeus* is interesting. Here are the grades according to a man's spiritual worth and experience: (1) philosopher, artist, musician; (2) king, warrior; (3) politician, trader; (4) gymnast, physician; (5) prophet; (6) poet; (7) farmer; (8) demagogue; and (9) tyrant.

Gnostic Christians had this same doctrine of reincarnation, as had the great scholar, Origen, but it was condemned at the Second Council of Constantinople (A.D. 553): "Whosoever shall support the mythical doctrine of the pre-existence of the soul, and the consequent wonderful opinion of its return, let him be anathema." Words like these, true or not, are certainly not inspired by the Spirit of Christ.

Unconsciously, of course, there are many people who have loved this idea, put into poetic form.

Recall, for example, the familiar lines from Wordsworth's "Intimations of Immortality":

"Our birth is but a sleep and a
forgetting;
The Soul that rises in us, our
life's Star,
Hath had elsewhere its setting,
And cometh from afar:
Not in entire forgetfulness,
And not in utter nakedness,
But trailing clouds of glory do
we come
From God, Who is our home."

How few of our children, repeating that at school, know that they are incurring the awful anathema of the majestic Council of Constantinople!

In any case it is the simple child-like spirit that enters the Kingdom, not the cursings at which early Church Councils were often so adept.

Flaws in Hinduism

Hinduism, as might be expected, is a very undeveloped religion. It has only the vaguest idea about God. It seeks to escape life—here or hereafter. It is non-moral, except for the enlightened few. It has a cruel and immovable caste system, which makes impossible even the natural humanity of man to man. But from its ancient books and its deepest thinkers come many noble sayings.

A few are gathered here, quaintly mixed with crude ideas that make us either sigh or smile:—

"God builds the nest of the blind bird."

"Cast thy bread upon the waters; God will know of it if the fishes do not."

"Let things take their course; there is a God."

"There are no two together but God makes a third."

"This is the sum of true righteousness—treat others as thou wouldst thyself be treated —do nothing to thy neighbour which hereafter thou wouldst not have thy neighbour do to thee, in causing pleasure or in giving pain, in doing good, or injury to others." (*The Golden Rule.*)

"He who bathes in the Ganges purifies seven descendants. As long as the bones of a man touch Ganges water so long that man is magnified in Heaven."

"Let no man eat beef. Whoever eats it will be reborn as a man of ill-fame."

"A fat man has no religion."

"Kine are of divers colours, but all milk is alike; the kinds of flowers vary, yet all worship is one; systems of faith are different, but the Deity is one."

"Through avarice wrath gains the mastery: through avarice desire comes into being; through avarice is produced confusion and destruction. Avarice is the root of all evil."

"The lamp that burns most brightly owes its force to oil drawn upwards by a hidden wick."

"Compassion is the root of religion, pride the root of sin."

"Virtue is spotlessness of mind; all else is mere noise."

"Brahmin vows (1) Not to injure living beings; (2) Not to lie; (3) Not to steal; (4) To be continent; (5) To be liberal."

Sayings like these are like sunshine coming fitfully through dark, drifting clouds. They show that a primitive mind can sometimes go to the very heart of things—like the questions of a child. They prove that no one religion has a monopoly of truth. As Jung said, "Columbus, by using subjective assumptions, a false hypothesis, and a route abandoned by modern navigation, nevertheless discovered America."

Rise of Buddhism

The profound inner pessimism of India is even more evident in Buddhism, with its 520 million believers. In India itself it has been dying out since the twelfth century, but in the first century A.D. it got a strong hold in China, and, five centuries later, in Japan. Other areas where it has flourished are Ceylon, Burma, Thailand, Mongolia, and among the Kalmucks of Russia, but for some seven centuries it has not expanded, and with the awakening of the East it would seem unlikely that so complete a denial of the will to live will continue. The rapid advance of Christianity in the East in recent years is a sign that no negative religion can satisfy the deep human needs so obvious in Eastern lands.

Buddhism is simply and solely an escape from life. It was founded by Gautama, the son of a very rich Hindu rajah. Though surrounded by the most ostentatious luxury, there was an unrest at the heart of him. He believed neither in God (for Buddhism as he founded it has no God), nor in the soul of man, which he considered to be nothing more than a temporary conglomeration of desires. The stern injunction against selfishness is not what it appears. Some consideration of other men is in it, as can be seen from the Buddhist version of the Golden Rule—"Hurt not others with that which pains yourself," but the real object is always the elimination of self—the pursuit of that Nirvana of "passionless peace" which was the heart's desire.

At the age of twenty-nine, Gautama saw four sights which sickened him—an old man in infirmity, a very sick man, a corpse, and an ascetic who had schooled himself by long contemplation and discipline to a point when any misery could be regarded with complete detachment and untroubled calm.

Gautama's Renunciation

From that moment he made up his mind to a great renunciation. He left his wife, his new-born son, his palace, and his inheritance. Garbed as a monk he set out to seek peace. Hinduism he rejected. "He came not out of the mire."

Jainism (founded by Mahavira, 599-527 B.C.), which preached that evil is mainly to be located in the

BUDDHA, THE ENLIGHTENED ONE

Buddha taught that the elimination of desire brings Nirvana, which means serenity of mind, and he laid down eight rules for its achievement. He has millions of followers in China, Japan, Tibet and Ceylon, but few now in India. He is shown here beneath the Bo-tree, where enlightenment came to him.

body, and enjoined the most severe bodily repression, such as living on one grain of rice a day, he also put aside. At last, deserted by his few companions, sitting quiet one night under a Bo-tree, he felt suddenly enlightened. He reasoned out with himself the four noble truths: (1) that all existence is suffering; (2) that the cause of suffering is desire, leading to re-birth; (3) that the cure for suffering must be the destruction of all desire; and (4) that this can be accomplished by following the Holy Eightfold Path, the Middle Way. This Eightfold Path (avoiding the extremes of sensual desire and asceticism and so the Middle Way) consisted of Right Belief, Right Aspiration, Right Speech, Right Conduct, Right Means of Livelihood, Right Endeavour, Right Memory and Right Meditation.

Changes in Buddhism

With a great deal of reluctance he began to preach these doctrines in North India, denouncing Hinduism. At the age of eighty he died. The name by which he was and is known was Buddha, "the enlightened one"—and to be a Buddha at long last was the aim of all his followers.

After his death his life and teaching were held in the greatest veneration. Followers of the Hinayana (Lesser Vehicle) looked upon him as a great prophet. Other followers of the Mahayana (Greater Vehicle), especially in China and Japan, held him to be Divine. Thus, in complete contradiction to his own teaching he was worshipped as a god, and generally through an image. Buddhism in its present form has suffered a vital change, and this must be remembered.

Doctrine of Despair

As a whole Buddhism is a religion of despair. It accepts fully the doctrines of Karma and re-incarnation. Obviously there is some inner contradiction, for if, as Buddha taught, there is no soul, how can that soul be reborn? However, the faith of his followers was centred upon his own experience. The way that he had found they were anxious to follow, and very devoted followers they have been.

In Japan the chief sect of Buddhism is the True Pure Land Sect, who offer worship, not to Buddha himself, but to Amida, the Lord of the Western Paradise. Here is another fundamental change, almost out of all recognition. The great aim of life with these Japanese Buddhists is not extinction but bliss with Amida in Heaven, to which they are helped much more by His saving help and grace than by any effort of their own. How a religion changes as generations come and go! The human heart seems to cry out beyond all logic for a god to worship and for the aid that he can give.

In its later years in India Buddhism became corrupt and decadent, falling away gradually before the power of Islam.

Here are just a few of its proverbs and sayings:

"A man does not become a Brahmin by his plaited hair, by his family or by birth; in whom there is truth and righteousness, he is blessed, he is a Brahmin." (Note: Buddhism cut right across the Hindu system of caste.)

"Except a grain of corn die, it abideth alone; but if it die it bringeth forth much fruit."

"Those who have a hundred dear ones have a hundred woes; those who have one dear one have one woe; those who hold nothing dear have no woe."

"The devils ahead are the same as those behind."

"When a man dwells alone, he is a Brahmin; where two dwell, they dwell as gods; where three dwell it is a village; where there are more it is a rabble."

"There are one hundred and thirty-six hells."

"I would be a protector of the unprotected, a guide of wayfarers, a ship, a dyke, and a bridge for them who seek the further shore; a lamp for them who need a lamp, a bed for them who need a bed, a slave for them who need a slave."

"Wherein does religion consist? It consists in doing as little harm as possible, in doing good in abundance, in the practice of love, of compassion, of truthfulness and purity, in all walks of life."

"All that we are is the result of what we have thought. . . . If a man speaks or acts with an evil thought, pain follows him as the wheel follows the foot of the ox that draws the carriage, but, if a man speaks or acts with a pure thought, happiness follows him like a shadow that never leaves him."

(This insistence, as in Hinduism, on the power and pervasiveness of thought is clear enough in Christianity, but as yet has been insufficiently realized by Christian teachers. It is a revolutionary idea, which would give new vitality to a Gospel, as yet only half-interpreted.)

"This world is but an inn."

Religion in Japan

Before discussing the two great religions of China, there must be a glance at Japan. There the native religion, dating from 660 B.C. or thereabouts, is Shinto (the Way of the Kami or Gods). At the 1936 census it had 17 million believers. Shinto began by being a nature religion with a great many gods—800 myriads of them were said to have held a council in the Milky Way!—but supreme above them all reigned the Sun Goddess, Ama-Terasu (the Heaven-Shining One). Others were the Moon God, the Star God, the Storm God, and so on, but added to these in later years were deified persons, including emperors, princes, heroes of every sort, and for each man his own ancestors.

The important thing in Shinto is its development into a State religion

having at its centre the worship of the Emperor, who was considered divinely born and in direct descent from the Sun Goddess. Loyalty therefore became the first virtue. To repudiate Shinto meant treachery to the Emperor and State. But this is no ordinary loyalty. It has in it the religious passion of a strong faith. The power of that faith, turned, as inevitably it had to turn, to a fanatical belief that Japan was the Chosen Nation, destined to subdue the world, we have good reason to know.

It would arouse some apathetic Christians if they would only realize the terrific impact of any religious faith. A faith of this kind can have few moral results. Indeed it attempts no moral results at all. There are thousands of Shinto shrines, at which prayer is made, always for material blessings. But there is little or nothing about the salvation or destiny of the individual who prays. Personal cleanliness is a strict obligation, but this is an outward matter of ritual, and has no relation to the inner life.

Mixture of Doctrines

Bushido (the knight's way of honour) is a compilation from Shinto loyalty, Confucian filial duty, and Buddhist disdain both of life and death. It enjoined—with the fundamental loyalty—virtues like courage, self-sacrifice, benevolence (of a negative kind), justice, self-control. Plainly, it was quite an artificial code, with no strong religious sanction within it, and its hold upon the people has long ceased to count. Nevertheless the fanatical faith of it—very like the Nazi faith of Germany—is a phenomenon which demands much more consideration than other nations have yet given to it. Here quite plainly is a force to be reckoned with. What is that force? If we want to analyse human motives—as we must—we must answer that question.

Shinto Precepts

It is worth while, in fairness, to add a few Shinto proverbs:

"See no evil, hear no evil, speak no evil."

"Though a man work off his bodily filth, he will yet fail to please the Deity if he restrain not his evil desires."

"Practise the art of giving up."

"The gods are useful when all else fails."

"Misfortune also becomes a bridge to happiness."

"The Ten Negative Precepts: Do not transgress the will of the gods: Do not forget duty to ancestors: Do not disobey the State: Do not forget the goodness of the gods: Do not forget that the world is one great family: Do not forget your own personal limitations: Do not give way to anger, even if others are angry: Do not be slothful: Do not bring discredit to the teaching: Do not be carried away by foreign teachings."

A strange and explosive mixture! The oldest religion in China

—with some 43 million believers—is Taoism. Its founder was Lao-tze, born in 604 B.C., fifty years before Confucius, the contemporary of Zoroaster in Persia, Mahavira and Buddha in India, Jeremiah, Ezekiel and Isaiah (that is—the Second Isaiah) in Israel. Not much is known of him. He was the Keeper of the Archives at the Court of Chou, but an obscure figure, withdrawing from life in accordance with his own teaching. Organized Taoism seems to have started in the first or second century A.D. by the initiative of Chang Tao-ling.

Doctrine of Inaction

Like Buddha, Lao-tze was deified after his death—in the eighth century A.D. In his teaching, however, there was very little mention of any Supreme Being. The great word in it is "wu-wei"—inactivity. The art of life was to withdraw from life, to acquiesce, to become a calm, placid, gentle, humble, frugal being, free from every form of self-assertion. In fact it was the line of least resistance.

Dr. Lionel Giles, speaking of the *Book of Rewards and Punishments* (eleventh century A.D. and popular even now) says: "It is a short tract setting forth a number of actions and qualities, good and bad, from which retribution may be expected to follow in the form of a lengthening or shortening of life: if at death there remain any sins unpunished, they will be visited on the next generation." No future life was ever considered.

Three quotations will describe what Tao (the Way) really involved:

> " So long as I do nothing the people will work out their own reformation. So long as I love calm, the people will right themselves. If only I keep from meddling, the people will grow rich. If only I am free from desire, the people will come naturally back to simplicity."

> "Repose, tranquillity, stillness, inaction—these were the levels of the Universe, the ultimate perfection of Tao."

> "I have three precious things which I hold fast and prize. The first is gentleness; the second is frugality; the third is humility, which keeps me from putting myself before others. Be gentle and you can be bold; be frugal, and you can be liberal; avoid putting yourself before others, and you can become a leader among men."

Confucianism

The main religion of China is Confucianism. Its founder, Confucius (551-479 B.C.) was a local sage, a teacher, and the holder of various government appointments in one state or another. In middle life he became a preacher of good government and private manners. The two in his idea of things always went together. His teaching was very definite about the moral order of the universe, but equally vague about the Supreme Being, who in any case could only be worshipped by the Emperor. All other worship

was of the kind so familiar in nature religions.

"The Son of Heaven sacrificed to Heaven and Earth, to all the famous hills and great streams under the sky, the five mountains and the four rivers. The Princes of the States sacrificed to the spirits of the land and grain, to the famous hills and great streams which were in their own territories."

Virtue of Filial Piety

The chief injunction of Confucianism is ancestor-worship. This is a continuation of that filial piety which Confucius considered the most noble of virtues. "The services of love and reverence to parents when alive, and those of grief and sorrow to them when they are dead: these completely discharge the fundamental duty of living men."

A religion so devoted to the worship of ancestors might have been expected to produce some clear doctrine of the Life after Death, but there is nothing of the kind. What is clear is the continued conscious existence of ancestors, still interested in their children and successors, still anxious to assemble at the ancestral Tablet "to be told things" about the family life on earth. It could be wished that the Communion of Saints—a very different doctrine indeed—meant as much to the Christian people who profess to believe it. Here perhaps we have something to learn.

Worship, such as it is in Confucianism, is mostly a matter of ritual and ceremony. Confucius himself did not pray, as we understand prayer. Its ethics or rules of character range themselves round two words—propriety and reciprocity.

Reciprocity, called the Silver Rule in Confucianism, is the negative of the Golden Rule, as we generally call it. "What you do not want done to yourself, do not do to others." Propriety involved such virtues as sincerity, faithfulness, justice, benevolence, reverence, moderation, calmness, and good manners. Indeed Confucianism might in general be termed a religion of good manners, using the word manners in its widest sense. But these good manners were never extended to women. "The woman follows and obeys the man."

Secret of Inner Calm

It will be noticed also that Confucianism is very superficial. It makes no attempt to deal with the deep maladies of human nature nor its insistent aspirations. Nevertheless, it remains, on the whole, the religion of 400 millions of Chinese who, in a world of change, seem to have some calm inner secret of their own. That again deserves a careful and unprejudiced examination.

To us humans it is not given to see the whole truth, but it behoves us to seek the world for it and to respect it none the less when in an old religion like this it comes humbly. Temples were raised to Confucius in the sixth century B.C.,

for whatever a great teacher may say, his disciples before long insist upon a god, and may make him one himself, when he is no longer able to protest!

The aphorisms of Confucius are very well known. A few of them here will help us toward some understanding of what this religion, at its best, really means:

"Adversity is sometimes the rain of Spring."

"Benevolence is the distinguishing characteristic of man."

"The bird chooses its tree; the tree does not choose the bird."

"Without tasting the bitterest we can never reach the highest."

"Help thou thy brother's boat across and lo, thine own hath touched the shore."

"A man without charity in his heart—what has he to do with ceremonies?"

"The man who in the view of gain thinks of righteousness; who in view of danger is prepared to give up his life; and who does not forget an old agreement, however far back it extends—such a man may be reckoned a complete man."

"The Master was entirely free from four things: prejudice, foregone conclusions, obstinacy, and egoism."

"It is not the knowing that is difficult, but the doing."

"Life is a bridge, and there is no time to build houses thereon."

"It is better to put a lamp in a dark place than to light up a seven-storied pagoda."

CONFUCIUS

Confucius, the Chinese sage, considered that ceremonial ancestor-worship was of supreme importance.

"The ways are two: love and want of love. That is all."

Zoroastrianism, the religion of Iran or Persia, has very few adherents nowadays, about 125,000, but it comes nearest of all religions to Christianity, and indeed has influenced Christianity not a little through the Old Testament. For example, King Cyrus (mentioned in Isaiah) was a Zoroastrian and in much later times the Magi or Wise Men who came with their gifts to Bethlehem, were of the same faith.

Zoroaster himself was born in 660 B.C. What an age that was for great religious personalities! Not very much is known of him, except

through legend, but at the age of thirty he felt called to purify himself as a prophet. He preached what is called Monotheism—One All-wise All-holy God—Ahura Mazda (Ormuzd). The attributes or qualities of God, such as righteousness, power, humility, beneficence, were soon regarded as definite personalities, archangels, male and female, the retinue of Ahura Mazda. In number they were six —the Beneficent Immortals.

Belief in Angels and Spirits

Below these in rank came the angels (Yazatas) "hundreds and thousands." Ancestor worship was introduced into later forms of Zoroastrianism, but it concerned itself with something more than the spirits of the dead. To quote Dr. Cave: "Each living being of the good creation has a higher counterpart. Not only has every good man, as his guardian angel, an immortal spirit, his ideal self, but the gods also have their Fravashis; even Ahura Mazda has his." The spirits had to be appeased. To omit a feast for them was highly dangerous.

There are some who think that the Christian belief in angels came from this old religion of Persia. Almost certainly (in view of the Jewish exile) there was some definite influence, but our belief is a very different belief. We are in no danger of giving too much honour to archangels or angels, much less of trying to avert their enmity against us. Our danger is the opposite—of refusing to believe in any angelic beings at all, though the whole Bible assumes their continual presence and Christ Himself spoke of them plainly. It is our misfortune and the penalty of our materialistic age that we believe only what we see, and seem almost to have lost our faculties for apprehending the Unseen.

Zoroastrianism was a dualistic religion. It believed in One God (Ahura Mazda), contending for the good, and in a Supreme Devil (Angra Mainyu), the Lie Demon, actively fighting to spread evil. The Devil was attended by numberless myriads of demons, who appear to be evil qualities personified—Hunger, Thirst, Wrath, Arrogance, Greed, Lying, Drought, Winter, and the like. The importance of this lies in the fact that Zoroastrianism did realize what most other religions disregarded —the sinister and insistent problem of evil. The aim of the believer was not to escape life here or hereafter, but to attain to virtue, deserving —after an inevitable Last Judgment —of a heavenly reward. But it was a fight from start to finish, and the war was in the very heavens too. Every man was to "fight the Lie." Unfortunately this fighting spirit in the end made Zoroastrianism, like Islam, a religion of violence —"Resist them then with weapon."

Undying Fire

Worship consisted in repeated prayers, ceremonial cleansings, and in the maintenance of a fire that never died out. But the Zoroas-

ZOROASTRIAN FIRE TEMPLE

Nearly 600 years before the birth of Christ, Zoroaster preached in Persia that there was only one god. Though it has few followers now, Zoroastrianism approaches most nearly to Christianity. Part of its worship consists in maintaining an eternal fire. The illustration shows a Zoroastrian Fire Temple, reproduced by the courtesy of Professor Alban G. Widgery.

trians were not "fire-worshippers," except in the sense that fire with other elemental forces was nearly always offered some kind of worship in early Nature religions.

In the end a man was to be judged by his actions. To quote Dr. Cave again: "This world is connected with the next by the Bridge of Separation. It is at this bridge that the difference between good and evil shall be revealed. The soul of the Liar shall tremble . . . but Zoroaster will himself accompany across the Bridge of the Separation those whom he has impelled to the adoration of Ahura Mazda."

Two quotations must suffice:

"These four habits are the principles of the religion of Zoratust: to exercise liberality in connection with the worthy; to do justice; to be friendly to every one; to be sincere and true and to keep falsehood far from themselves." And this, which is surely a moral for our times:

"Thou shouldst not be too much arranging the world; for the world-arranging man becomes spirit-destroying."

Islam (submission), like Buddhism, sprang from the preaching of a rare and vital personality—Muhammed, born at Mecca in A.D. 570. The strong emphasis of

his preaching—collected at a later date into the Sacred Book, the Koran—was on the Oneness of God. There were no other gods at all and idols must be prohibited and broken down.

This was rather too much for the people of Mecca, which depended for its prosperity upon the coming of pilgrims to the local shrine, the Kaaba. So Muhammed had to flee for his life—the Hegira in 622—to Medina. It was from Medina that Muhammed made himself felt, and from that time must be reckoned the beginning of the Moslem era.

A shrewd and able statesman as well as a preacher of fierce sincerity, he succeeded in uniting

MUHAMMED

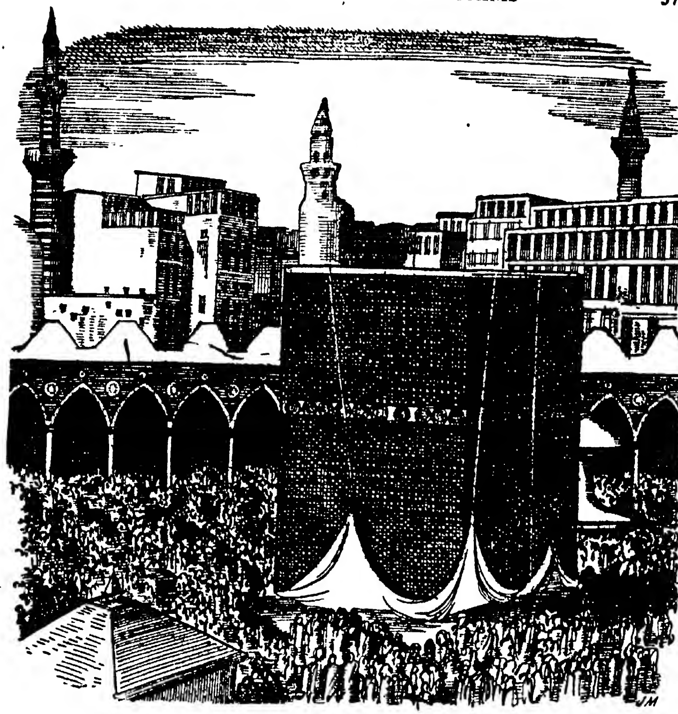
Muhammed preached the doctrine of submission (Islam) to one God, whose prophet he claimed to be. Later he took up the sword against unbelievers.

Arabia and in becoming the dominant power within it. Today there are 300 millions of Moslems scattered throughout the East, including some 90 millions in India alone. Arabia and most of North Africa are Moslem, and the majority of the population in the Malay States, Palestine, Syria and Iraq.

In his own lifetime Muhammed claimed only to be a prophet, but as years went by his followers insisted upon giving him a higher honour than that, "the last and greatest of the prophets," associating with him all sorts of legendary miracles, declaring him to be sinless and a manifestation of God.

He preached "deliverance," which would only be by faith, by submission to Allah, and by obedience. Prayer was a duty of supreme importance—five times a day—consisting in actions, phrases, recitations, often repeated. Here at the very least is earnestness. It is not for Western civilization to feel superior to the Arab with his prayer mat and his face turned towards Mecca!

There was also fasting, including the Great Fast of Ramadan, when for a month no Moslem could eat or drink in the daytime. No further proof is needed that they took and still take their religion seriously. Almsgiving was a very strict injunction. At least one pilgrimage to Mecca was demanded. In later years there was preached the Jihad—the war of the sword against unbelievers. A glance at history will show how far into Asia and Europe



HOLY OF HOLIES OF ISLAM

The Kaaba is the sacred shrine, containing a black meteorite fragment, at Mecca, to which every Muhammedan hopes to make at least one pilgrimage.

that warlike campaign took them.

Islam contains within it much that was taken from Judaism and Christianity—for example, belief in the Resurrection, the last Judgment and Life after Death. It also brought into Europe a great deal of culture, some of it learnt from the Greeks. Arabesque in architecture—the consequence of the prohibition about images—has left a peculiar grace and dignity of its own in Spain, Morocco and elsewhere.

It may be best, in this limited space, perhaps, to let a few of its proverbs speak for themselves:

"My earth and my heavens cannot contain me; but the heart of my slave, the pious, pure, and God-fearing true believer, can contain me."

"Say your prayers in a congregation, for a wolf does not eat a

sheep except one has strayed from the flock."

"Allah never creates a river without its crocodile."

"He who sows the seeds of thorny brambles in the world—see you seek him not in a rose garden."

"You cannot have both God and dates."

"The dawn does not come twice to awaken a man."

"Manage with bread and butter till God brings the jam."

"God could not be everywhere so He sent mother."

"God may work much mercy before the morning."

"Beware of using the word 'if,' for verily it is of the words of the hypocrite."

"If a man hath two loaves, let him sell one and buy some flowers of narcissus."

"Verily, God will say in the Day of Resurrection, O ye sons of men! I was sick and ye did not visit me. And the sons of men will say, O thou Defender, how could we visit Thee, for thou art the Lord of the Universe, and art free from sickness? And God will say, O ye sons of men, did you not know that such a one of my servants was sick and ye did not visit him?"

"To be a cause of healing for every sick one; a comforter for every sorrowful one; a pleasant water to every thirsty one; a heavenly table for every hungry one; a guide for every seeker; rain for cultivation; a star to every horizon; a light for every lamp; a herald for every yearning one for the Kingdom of God."

"If a man think well of you, make his thought true."

"If the first of the wine-jar is dregs, what will the last be?"

"Women are of three kinds in the world: two of these are affliction, and one is the Treasure of the soul."

"Women have been omitted by God from His mercy."

"O God! Protect me from myself."

"The world is a bridge; pass over it, but build no house there."

God Reveals Himself

In this very brief survey of Comparative Religion it becomes very obvious that God has revealed Himself to every nation that has sought Him, always within the limitations of that nation in its slow development. There is much in some Eastern religions that we must reject, but we have to remember always that what we see is these religions in their very early growth. Some of them have grown very slowly. What we can anticipate is that the missionary work of the Christian faith will profoundly change many Eastern religions in the next hundred years, just as we can hope that they in turn will help us to understand more fully our own faith. It is well to remember also that Eastern folk have judged Christianity by the behaviour of Western Christians, and that has

MOSLEMS AT PRAYER

Prayer is regarded as the first duty in the religion of Islam. Every devout Moslem prays five times a day, kneeling on his prayer mat and turning toward the sacred city of Mecca, no matter where he is at the time.

not always been what it should have been.

For the most part Eastern religions are tolerant. In one sense Christianity is intolerant. It cannot allow any other faith to be mixed with it. The reason for that is clear enough, but Christianity is at its best when it is humble, as its Lord was humble, accepting gladly what is good from whatever source it may come, knowing that all truth is the same truth, and that Truth is God. We have no need of a broadmindedness which will believe anything, but of a humility of mind which knows well that truth comes always as a friend. In many of its modern interpreters Christianity is not so confident or so hospitable. They have something to learn, and not too much time in which to learn it.

Christian teachers have been very slow indeed to explain the development of Judaism—religion as set forth in the Old Testament. Yet the idea of God was only realized very gradually among the Jews, whose first ideas of Him were very like most other Eastern ideas and expressed themselves in much the same type of worship. It is of vital importance that people should realize that the Old Testament is not a Book but a Library. That

ST. FRANCIS OF ASSISI

St. Francis of Assisi, by his example of simplicity and devotion, spread the spirit of true Christianity in Europe. His wonderful love was extended to all living creatures.

Library is a record—from stage to stage—of the development of a religious consciousness, at first almost childish, which in the end, and mainly through the sublime moral teaching and fervour of the Prophets, became a genius for religion, unique among the nations of the earth. And it was at that point, of course, that Christ came, not to destroy but to fulfil.

Our biggest obstacle is the theory of Verbal Inspiration, which claims that the Bible (even in its English translation!) is word for word the Word of God from Genesis to Revelation. That theory has long been discarded by scholars, but it remains the general idea of the majority of people. The majority in any case rarely go to church.

Christianity is the supreme example of Monotheism. God is One. There can be no other. The Presence that disturbs us in spring or autumn, when every common bush seems "afire with God" and a country lane a veritable sanctuary, is the same Presence that we feel about us at the Altar. We talk sometimes of "God above," but we know very well that in Him we live and move and have our being. Therefore it is often His will to come to us in little things. A wayside flower may be a Sacrament, as Christ Himself once stopped to point out.

Nearly all that we know of God we see "in the face of Jesus Christ." He is "the Word made Flesh," not a prophet or a teacher or any temporary manifestation, but truly and eternally God. Christianity, then, is faith in Christ, faith which proves itself not only in formal acceptance but in trust and in action. It is He who guides along the road of common life. It is He who strengthens us with the inspiration of His own life. "I am the Bread of Life." It is He who saves us from our sins and from ourselves, touching us in our corruption now as He touched the lepers in Judea long years ago. And how desperately we need it!

Christianity without Christ (generally called Humanism) is nothing

but an impious parody. It is quite impossible to adopt Christian ethics or standards of behaviour without accepting Christ as Thomas did—"My Lord and my God." That is the mistake, most disastrous in its consequences, which we are making in this generation. No diluted Christianity, sweetened to taste, and separated as "our way of life" from Christ Himself, can help this distracted world. Even to attempt it is to plan another tragic frustration, more evil than the last. Every form of behaviour has its roots. It is not enough to tell a child to be good in any sense of that word. Soon he will ask, "Why?" There is no answer at all worth giving except in the deep inner allegiance and worship of the soul.

Many of the Eastern religions say "No" to life. The believer has no will to live. His one aim is to escape the probable doom of living again. Christianity says, "Yes." It is a very positive religion. It seeks to make men "whole," fully alive, and to lead them on to an eternal life beyond the reach of death. But here again Christianity is often grievously distorted. Christian art, in its popular forms at any rate, has depicted a very anaemic

CHRISTIAN CHURCH WHICH BECAME A MOSQUE

St. Sophia, built by Justinian in the sixth century A.D., *was the most wonderful and costly church in Christendom. When the Turks conquered Constantinople, they spared the church and converted it into a mosque, covering the beautiful mosaics with whitewash and plaster, now removed*

Christianity. So have many Christian hymns—and stained-glass windows in churches! In such ways as these our young people have formed the idea that the Christian life is a "goody-goody" life, long-faced, sour, strait-laced, and hedged about with a thousand stern prohibitions. That grim impression is not limited to children. It is shared by millions of adults, who have not yet learnt that in the New Testament "Thou shalt" is much more common than "Thou shalt not."

Christ's Teaching

The Commandments remain, but, taken by themselves, they are as negative as Buddhism. Not that we dare to disregard them; our need is to realize the continual teaching of Christ that our true spiritual condition and worth are to be judged much more by what we have not done. The aged, who dwell much upon that, have the mind of Christ.

The world is waiting for the fearless preaching of a positive and uncompromising Christianity. It must also be an honest Christianity, in which we who preach or write see to it that at all costs we do not make the Word of God of none effect by any outworn dogma or by any vexatious and unreal ecclesiastical tradition. That will be a hard task, but everything, for generations to come, depends upon it.

We must also be very definite about what Christ called sin. There is no amendment of life possible without a recognition of sin and guilt, and such real repentance as will result, by the grace of God, in amendment of life. Too long we have deceived ourselves with the Victorian idea of inevitable progress. The open devilry of these times has at last awakened us from that. But we may deceive ourselves again by the popular notion that we can rebuild the ruins of our world by better planning. That planning must include the planning of better men and women, though not so much is being said about that. Nevertheless, it remains true, if our belief is in Christ, that repentance—for our pride, for our lack of love, for our social indifference, for our callous cruelty to our neighbour—must come first. If it does not come first, then chaos must come again.

Underlying Truth in all Religions

Summing up, in a brief word or two, these Eastern religions, is it not amazing how, in spite of everything, the truth creeps in among the error? What beauty, most moving and compelling, is in many of their sayings and proverbs! Is it not astonishing that, in one form or another, the Golden Rule appears in them all—except Shinto? How did they know?

There come to mind words of Oliver Cromwell. Let them be the peroration. "To be a Seeker is to be of the best Sect next to a Finder, and such an one shall every faithful, humble Seeker be at the end. Happy Seeker, happy Finder."

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Numbers in italics indicate illustrations

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